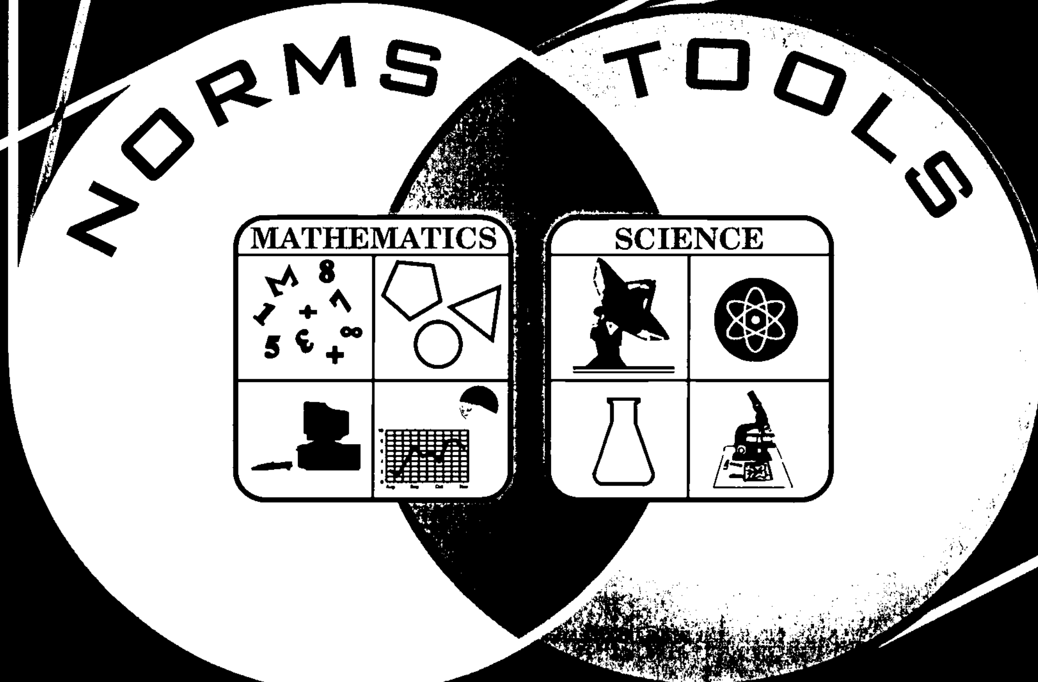
DOCUMENT RESUME

ED 474 056 SE 067 395

TITLE	Norms [and] Tools: A Roadmap to Professional Practice. Exemplary Teaching Practice.
INSTITUTION	CONNECT, Denver, CO.; Eisenhower High Plains Consortium for Mathematics and Science, Aurora, CO.; Mid-Continent Research for Education and Learning, Aurora, CO.
SPONS AGENCY	National Science Foundation, Arlington, VA. Office of Systemic Reform.; Eisenhower Program for Mathematics and Science Education (ED), Washington, DC.
PUB DATE	1999-05-00
NOTE	71p.; Developed by CONNECT (Colorado Statewide Systemic Initiative for Mathematics and Science).
CONTRACT	OSR-9350041
AVAILABLE FROM	McREL, 2550 S. Parker Road, Suite 500, Aurora, CO 80014. Tel: 303-337-0990; Fax: 303-337-3005; Web site: http://www.mcrel.org.
PUB TYPE	Guides - Non-Classroom (055) -- Reports - Descriptive (141)
EDRS PRICE	EDRS Price MF01/PC03 Plus Postage.
DESCRIPTORS	Curriculum Design; *Demonstration Programs; Elementary Secondary Education; Learning Processes; Mathematics Education; *Professional Development; Science Education; *Teaching Methods
IDENTIFIERS	Colorado

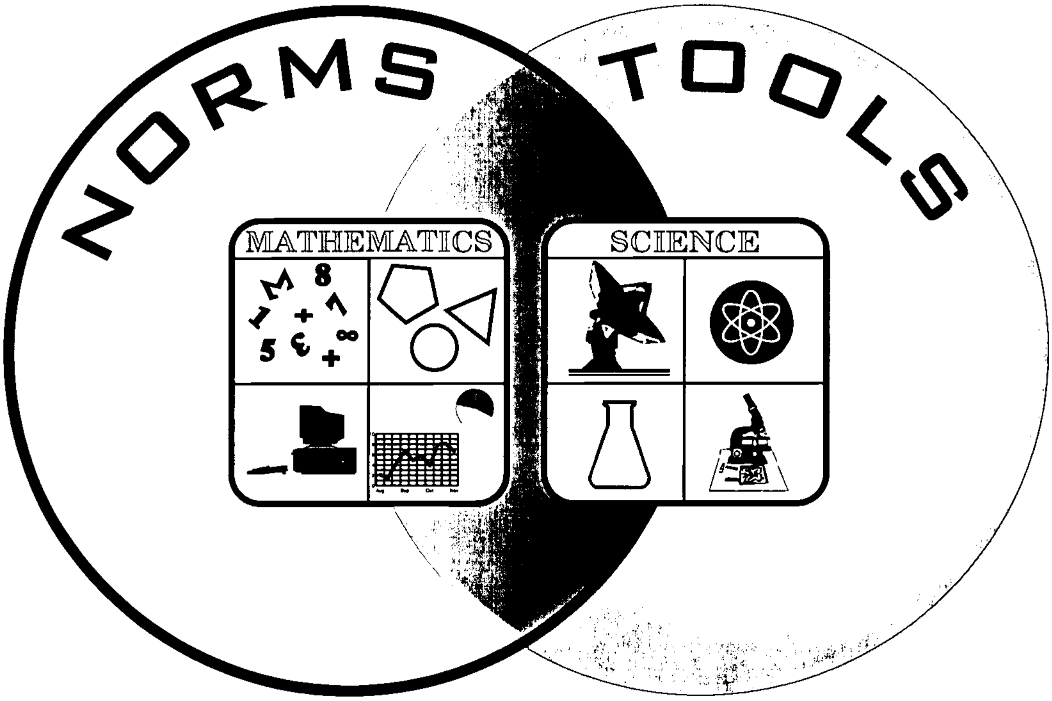
ABSTRACT

The Colorado Statewide Systemic Initiative for Mathematics and Science, funded by the National Science Foundation (NSF), has organized norms and tools for an Exemplary Teaching Practice project. This document identifies the norms of exemplary practice and provides an instrument that allows educators to develop a vision of how exemplary teaching and learning of mathematics and science appears. The document contains three components: (1) a description of the norms of exemplary practice; (2) mathematics and science vignettes; and (3) a list of tools to support the norms of exemplary practice. (KHR)



A Roadmap to Professional Practice

EXEMPLARY TEACHING PRACTICE



EXEMPLARY TEACHING PRACTICE

A Roadmap to Professional Practice

Developed by

CONNECT

EVERYONE CAN DO MATH AND SCIENCE.

Colorado Statewide Systemic Initiative
for Mathematics and Science

PRACTICE

McREL Eisenhower
High Plains Consortium
for Mathematics and Science

McREL
Mid-continent Regional
Educational Laboratory

2550 South Parker Road, Suite 500, Aurora, CO 80014
Telephone: 303-337-0990 Fax: 303-337-3005
http://www.mcrel.org

This material is based upon work supported wholly or in part by Grant No. OSR-9350041 from the Office of Systemic Reform, National Science Foundation and Grant CFDA No. 84.168R from the National Eisenhower Mathematics and Science Programs, U.S. Department of Education. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation or the U.S. Department of Education.

Art Direction: *Lamb Design* 303-795-2599
Digital Prepress: *IV Color Design & Imaging* 303-432-7971
Printing: *Little Books & Manuals* 303-674-6140

 Publication Date: *May 1999*

CONTENTS

RECOGNITION

CONNECT, the Colorado Statewide Systemic Initiative for Mathematics and Science, has provided leadership, guidance and materials to further changes in education for Colorado educators for the past five years. During that period, two other publications have been produced: *EQUITY – The Dialogue Among Stakeholders* and *PROFESSIONAL DEVELOPMENT CRITERIA – A Study Guide for Effective Professional Development.*

A Roadmap to Professional Practice – NORMS and TOOLS for EXEMPLARY TEACHING PRACTICE is the last of the publications in this set. This publication is a set of norms for effective teaching, coupled with the tools that can help educators attain them.

Under the visionary leadership of the CONNECT staff, especially Fran Berry and Nancy Kellogg, this project was originally funded by a CONNECT grant and was contracted to the Colorado Partnership for Educational Renewal (CPER) for initial development. There, the primary work was undertaken by two graduate students: Jennifer Bush of the University of Northern Colorado and Janet Carlson Powell of the University of Colorado at Boulder.

There were many contributors to this publication, participating in the project focus groups and serving as reviewers, which included CPER staff, CONNECT staff, and the Mid-continent Regional Educational Laboratory High Plains Consortium (McREL HPC) staff.

This final publication was refined and published through a contract with the Mid-continent Regional Educational Laboratory, under the leadership of Arlene Mitchell.

A Roadmap to Professional Practice: A Standards Response

In educational vernacular, issue-related buzz words come and go with regularity. Some words have more staying power than others, depending on needs and practices. "Standards" is the persistent issue-related buzz word of the 90s. Many researchers, politicians, and educators have responded to current standards issues by generating an abundance of resources in both print and electronic media. Educators can now choose from articles, reports, books, videos, and Web sites that feature classroom applications of mathematics and science standards. These standards evolve from various perspectives, including each state's educational philosophies, content area, and generalized teaching practices. Where standards once existed in moderation, teachers can now draw upon a wealth of resources to apply to their respective curricula. But how are they to choose which standards to address? Is there a way to balance the demands of various standards documents? How do the documents support each other?

CONNECT, Colorado Statewide Systemic Initiative for Mathematics and Science funded by the National Science Foundation, recognizes these questions and has organized the Norms and Tools for Exemplary Teaching Practice project. This project centers on the publication of a guide, *A Roadmap to Professional Practice*, that identifies the norms of exemplary practice.

The Goal

The goal of *A Roadmap to Professional Practice* is to provide an instrument that allows educators to traverse previously uncharted territory with the use of one document. After reading this document, educators may develop a vision of how exemplary teaching and learning of mathematics and science looks. This vision can give way to strategies and transform concepts into reality.

The Message

A recurring theme in this set of norms is that exemplary teaching enables and fosters the learning of every student. The language of this document centers on learners as individuals. One reason for this approach is that too often there are young people from economically disadvantaged families who are left out of the educational process. These students simply do not have access to the tools, language, and other forms of cultural capital that are second nature to students from middle and upper class backgrounds. One of the challenges inherent in exemplary teaching is to reach all students in a meaningful manner. *A Roadmap to Professional Practice* is designed to help educators meet that challenge.

The Structure

A Roadmap to Professional Practice has three components: (1) a description of norms of exemplary practice; (2) mathematics and science vignettes; and (3) a list of tools to support the norms of exemplary practice.

(1) Norms Description

The description of norms is a narrative designed to articulate a vision of the practices that support exemplary teaching. Rather than narrowly defining the term "teaching," the norms narrative uses the term to capture a broad array of thoughts and actions. These activities occur in educational settings and make it possible for students of all ages to learn.

The norms of exemplary teaching practice are based on ideas that appeared in the Colorado Licensure Standards, the National Council of Teachers of Mathematics Professional Teaching Standards, the National Science Education Standards, the Colorado endorsement rules for science, and the National Board for Professional Teaching Standards (early adolescence/science). In selecting potential norms, a list of three criteria that served as filters were identified. The result is that ideas

continued on next page

that met two or more criteria are included in the statements of norms of exemplary teaching practice.

- ▲ The first criterion was that of **frequency**. If an idea was emphasized in all or most of the standards documents, this was considered favorable.
- ▲ The second criterion was that the ideas about teaching and learning had to be supported by **research** on teaching.
- ▲ The third criterion was that an idea had to be communicated in **clear language** regarding exemplary practice.

(2) Vignettes
The purpose of the vignettes is to stimulate conversation with others about classroom practices. Some key questions that might be used are: How does this vignette fit the norm being described? What embedded assessments within the classroom actions are found in this vignette? State examples from the vignette that are similar to your own teaching practices. What changes could occur in your teaching as a result of the vignette?

The Mathematics Vignettes are adapted and reprinted with permission from Professional Standards for Teaching Mathematics, copyright 1991 by the National Council of Teachers of Mathematics. All rights reserved.

The Science Vignettes are adapted and reprinted with permission from the National Science Education Standards, copyright 1996 by the National Academy of Sciences. Courtesy of the National Academy Press, Washington, D.C. All rights reserved.

(3) List of Tools
The tools are a list of materials that exemplify and illuminate the norms. They are not an exhaustive list of all that is available, but serve as a helpful resource to educators. Tools also serve to bridge the gap between theory (the norms) and practice (the classroom). There are tools provided for each norm, including videos, articles, books, reports, and Web sites. Under each tool is a listing of where the materials may be obtained. Many public libraries offer an interlibrary loan service that can locate many of the journal articles and books.

Practical Use
A Roadmap to Professional Practice will be used by diverse populations, including individual practitioners who want to reflect on their respective practices, school improvement teams who want to create a vision of what teaching and learning could be, or staff development leaders who want to start an ongoing discussion about exemplary practice.

It is important to recognize that no teacher teaches in the manner suggested by these norms 100 percent of the time. However, all teachers have room for growth in their professional practices. These norms of exemplary practice, together with the identified tools, can provide a guide for inspiration and growth in classroom practices in our present day and beyond.

SYNOPSIS

Norms of Exemplary Practice

NORM 1: Nature and Teaching Theory of Discipline

Exemplary teaching of mathematics and science requires an understanding of the nature of those disciplines and current theory related to their teaching.

NORM 2: Selection and Teaching of Content

Exemplary teaching of mathematics and science includes the careful consideration of how content is selected and taught.

NORM 3: Learning Theory

Exemplary teaching of mathematics and science incorporates an understanding of how learning occurs and uses that knowledge to create opportunities that foster success for all.

NORM 4: Learning Environment

Exemplary teaching of mathematics and science requires vibrant learning environments that encourage critical thinking and reflection.

NORM 5: Assessment Tools and Strategies

Exemplary teaching of mathematics and science includes the regular and systematic use of a variety of assessment tools and strategies so that assessment is interwoven with instruction.

NORM 6: Democratic Environments

Exemplary teaching of mathematics and science creates and sustains democratic environments by honoring individuals and cultivating community in classrooms and schools.

NORM 7: Contributions to the Profession

Exemplary teaching of mathematics and science includes taking the time to be reflective and to make contributions to the profession.

NORM 1

NATURE AND TEACHING THEORY OF DISCIPLINE

Exemplary teaching of mathematics and science requires an understanding of the nature of those disciplines and current theory related to their teaching.

Understanding any discipline requires a deeper knowledge than just knowing the facts of that discipline. To understand the nature of a discipline means that teachers understand how knowledge and processes are organized and questions are asked and answered within that discipline. To reflect this understanding in their teaching, teachers need opportunities to stay abreast of changes in theory, research, and accepted practice related to teaching, science, and mathematics. The professional development of exemplary teaching can occur on the individual level by participating in such activities as reading professional journals, talking to colleagues, and browsing the World Wide Web. Or it may occur on a larger level such as in joining professional associations or participating in school-wide in-service opportunities. Exemplary teaching involves a personal commitment to professional growth.

In order to understand the nature of the discipline and current theory related to their teaching, an educator should:

- ▲ *Develop and maintain an attitude of life-long learning.*
- ▲ *Continue to improve and increase the depth and breadth of his or her knowledge of mathematics and science.*
- ▲ *Participate in professional development activities that strengthen teachers' pedagogical content knowledge as well as their subject content knowledge.*
- ▲ *Access resources such as journals, media, and the Internet.*
- ▲ *Use inquiry, reflection, and interpretation of modeling and guided practice to build an understanding of, and skills in, the teaching of science or mathematics.*
- ▲ *Use the results of student assessment to improve practice.*
- ▲ *Join national and/or state professional organizations such as NSTA and NCTM at the individual or building level.*
- ▲ *Serve as a science or math resource person.*

Mathematics Vignette

(Adapted from NCTM Professional Teaching Standards, pp. 141-142)

A group of high school mathematics teachers met twice a month at their school for a seminar with mathematicians and mathematics educators from a nearby university. These teachers used computers in their geometry classes for the past year and a half. The seminar provided them with opportunities to discuss what was happening in their classrooms and to think about new ways of teaching and learning.

The computer software allowed students and their teachers to construct geometric shapes, to make measurements of lengths and angles, and to do computations based on these measurements, which provided an environment for open-ended exploration and discovery of patterns and relationships.

Although the teachers were excited about their use of computers in geometry, many voiced frustration in trying to make decisions about appropriate tasks for their students. Some teachers were comfortable focusing student attention on specific relationships, while others were dissatisfied with activities structured to lead students toward a particular "discovery." At times, many teachers felt that their own knowledge of geometry was inadequate to deal with questions and conjectures that arose from open-ended explorations.

Gloria described a task she assigned her class early in the year: "I wanted my students to learn that the sum of the angle measures in a triangle is 180 degrees; so, I had them construct a lot of triangles on the computer and record the angle measures. The software made it possible to collect a lot of data quickly and to make a generalization. I thought my students would remember the relationship better if they discovered it themselves."

Rich also reflected on the same task: "I was really reluctant to use that activity because it didn't seem like exploration. It made me feel that I would be directing the students toward a single result and not really taking advantage of the technology. But when Gloria told me about some of the things her students came up with, I thought it might lead in some interesting directions. I was amazed at what happened. My students didn't just see what I thought they would see; many of them went off in all sorts of directions exploring other shapes. One even asked about a circle! I wasn't quite sure where to go with that question, but it certainly seemed intriguing, and it took us into lots of other ideas when we discussed it in the seminar."

Constanza remembered a lesson that was especially important to her: "One of my students had constructed a shape on the computer screen that he said looked three-dimensional. We took off on a discussion of geometric models and representations of shapes, something I hadn't really expected to get into during that lesson. As we were talking about two- and three-dimensional shapes, Jan asked about a line. Well, a lot of the students thought that was boring, but then Raoul held up a paper clip and said he thought it was two-dimensional. And another student said that if you bent the paper clip, it would be three-dimensional."

"That set off a bunch of conjectures, with students coming up with good reasons for why the bent paper clip could be considered one-, two-, or three-dimensional. There was more there than I had anticipated, and I thought it would be a great topic for discussion in the seminar. It made us think about representations and how we describe and define geometric shapes."

The seminar was a place where teachers shared their struggles with colleagues and university faculty to develop meaningful activities for their students. For many of the teachers, one of the most valuable aspects of the seminar was the opportunity to extend their own understanding of geometry.

SCIENCE

Science Vignette

(Adapted from NSES, pp. 34-35)

While studying a vacant lot near school, several of Ms. F's third-grade students became fascinated with earthworms. Although she had never used earthworms in the science classroom, she knew she could use any number of small animals to meet her goals. Ms. F. felt she could draw from her experience and knowledge working with other small animals in the classroom. She called the local museum of natural history to talk with personnel to be sure she knew enough about earthworms to care for them and to guide the children's explorations. She learned that it was relatively easy to house earthworms over long periods. She was told that if she ordered the earthworms from a biological supply house, they would come with egg cases and baby earthworms.The children would be able to observe the adult earthworms, the egg cases, the young earthworms, and some of the animal's habits.

Before preparing a habitat for the earthworms, students spent time outdoors closely examining the environment where worms could be found. This fieldtrip was followed by a discussion addressing important aspects of keeping earthworms in the classroom, such as how students would create a place for the earthworms that closely resembled the natural setting? An earthworm from outside was settled into a large terrarium away from direct sun. Black paper was secured over the sides of the terrarium into which the children had put soil, leaves, and grass. A week later, the earthworms arrived from the supply company and were added to the habitat.

Ms. F. thought about what she wanted the children to achieve and what guidance she needed to give. She wanted the students to become familiar with the basic needs of the earthworms and how to care for them. It was important for the children to develop a sense of responsibility toward living things as well as enhance their skills of observation and recording. She also felt that this third grade class would be able to design simple experiments that would help the students learn about some of the behaviors of the earthworms.

In the first two weeks, the students began closely observing the earthworms and recording their habits. The students recorded what the earthworms looked like; how they moved, and what the students thought the earthworms were doing. They also described the color and shape of the earthworms. They weighed and measured the earthworms and kept a large chart of the class data, which later provoked a discussion about variation. They observed and described how the earthworms moved on the surface and in the soil. Questions and ideas about the earthworms continually surfaced. Ms. F. recorded these questions and ideas on a chart. She kept the students focused on their descriptive work. Ms. F. tracked what else the children might have wanted to find out about earthworms and how they would go about doing so.

The students generated many questions. The following is an example of some of them. How do the earthworms have babies? Do they like to live in some kinds of soil better than others? What are these funny things on the top of the soil? Do they really like the dark? How do they go through the dirt? How big can an earthworm get?

Ms. F. let all of the questions flow into a discussion. She asked the students to divide into groups and to see if they could come up with a question or topic that they would like to explore and examine how they could investigate the topic. The students engaged in lively discussion as they shared their proposed explorations. Ms. F. told the students that they should think about how they might conduct their investigations and that they would share these ideas in the next class.

A week later, the investigations were well under way. One group chose to investigate the life cycle of earthworms and found egg cases in the soil. While waiting for baby earthworms to hatch, they checked books about earthworms from the library. They also removed several very young and small earthworms from the terrarium and tried to decide how they might keep track of the growth.

Two groups investigated what kind of environment the earthworms liked best. Both struggled with several variables at once: moisture, light, and temperature. Ms. F. planned to let the groups struggle before suggesting that the students focus on one variable at a time. She hoped that they might conclude this on their own.

A fourth group tried to decide what the earthworms liked to eat. The students had already visited the library twice and were ready to test some foods. The last two groups worked on setting up an old ant farm with transparent sides to house the earthworms so that they could observe what the earthworms actually did in the soil and what happened in different kinds of soil.

In their study of earthworms, Mrs. F.'s students learned about the basic needs of animals, the structures and functions of one animal, some features of animal behavior, and life cycles. They also asked and answered questions and communicated their understandings to one another. They observed the outdoors and used the library and a classroom that was well equipped to teach science.

NORM 2

SELECTION AND TEACHING OF CONTENT

Exemplary teaching of mathematics and science includes the careful consideration of how content is selected and taught.

Curriculum is the intersection of the content that an educator teaches and the method that an educator uses to teach that content. A textbook often dictates the selection of content. This static, universal view of content often ignores the local setting as well as the nature of the discipline. Exemplary teaching of mathematics and science takes into consideration the local setting, the specific students, and the organization of the discipline when selecting and organizing instruction. In addition, teachers will need to align their instructional strategies carefully with the specific content they are teaching, recognizing that each concept may need multiple and different approaches in order to be understood.

In order to carefully select content, an educator should:

- ▲ *Use or develop conceptual frameworks to guide the organization and coordination of content and instruction for the year within a grade level and between levels.*
- ▲ *Coordinate curriculum and instruction so that scientific and mathematical concepts are focused and developed in depth.*
- ▲ *Analyze materials in light of the relevant national and state standards and adapt them as necessary to meet the spirit of the standards.*
- ▲ *Select instructional and assessment strategies that support the students' conceptual understanding of the chosen content and that serve a developmentally appropriate role.*
- ▲ *Use local resources, events, and people to frame instruction and content selection, but connect them to a bigger context in math and science.*
- ▲ *Use information about students' interests and cultural backgrounds to guide the decisions about curriculum and instruction.*
- ▲ *Find ways to give students a voice in the selection of content.*

NORM 2

Mathematics Vignette

(Adapted from NCTM Professional Teaching Standards, pp. 29-30)

Ms. Pierce is a first-year teacher in a large school. She uses a mathematics textbook, published about ten years ago, that her department has required her to follow closely. In the middle of a unit on fractions with her students, Ms. Pierce examined her textbook's treatment of division with fractions. She was trying to decide what its strengths and weaknesses were and whether and how she should use it to help her students understand division with fractions.

She noticed that the textbook's emphasis was on the mechanics of carrying out the procedure ("dividing by a number is the same as multiplying by its reciprocal"). The text told students that they "could use reciprocals to help" them divide by fractions and gave them a few examples of the procedure.

The picture at the top of one of the pages showed some beads of a necklace lined up next to a ruler—an attempt to represent that there are twenty-four 3/4-inch beads and forty-eight 3/8-inch beads in an eighteen-inch necklace. Ms. Pierce saw that this represented what it means to divide by 3/4 or by 3/8 and that the question was, "How many three-fourths or three-eighths are there in eighteen?" Still, when she considered what would help her students understand this, she did not think that this representation was adequate. She also suspected that students might not take this section seriously, for they tended to believe that mathematics meant memorizing rules rather than understanding why the rules worked.

Ms. Pierce was concerned that these pages were likely to reinforce that impression. She saw that the task would neither emphasize the value of understanding why, nor promote mathematical discourse.

Thinking about her students, Ms. Pierce judged that these two pages required computational skills that most of her students had (i.e., being able to produce the reciprocal of a number, being able to multiply fractions) but that the exercises on the pages would not be interesting to them. Nothing here would engage their thinking.

Looking at the pictures of the necklaces gave Ms. Pierce an idea. She decided that she could use this idea, so she copied the drawing only. She included at least one picture with beads of some whole number length—2-inch beads, for example. She asked students to examine the pictures and try to write some kind of number sentence that represented what they saw. For example, a 7-inch bracelet has 14 half-inch beads. This could be represented as $7 \div 1/2$ or 7×2. She tried to help them to think about the reciprocal relationship between multiplication and division and the meaning of dividing something by a fraction or by a whole number. Then, she thought that she could use some of the exercises on the second page but, instead of just having the students compute the answers, she would ask them, in pairs, to write stories for each of about five exercises.

She decided that she would also provide a couple of other examples that involved whole number divisors: $28 \div 8$ and $80 \div 16$, for example.

Ms. Pierce felt encouraged from her experience with planning this lesson and thought that revising other textbook lessons would be feasible. Despite the fact that she was supposed to be following the text closely, Ms. Pierce now thought that she could adapt the text in ways that would significantly improve what she could do with her students this year.

NORM 2

SCIENCE

Science Vignette

(Adapted from NSES, pp. 64-66)

Ms. J. was eager to begin the school year and was particularly looking forward to teaching a semester course on transmission genetics — how traits are inherited from one generation to the next. She taught the course before and read extensively about the difficulties students have with transmission genetics conceptually and as a means of developing problem-solving skills. She also was learning about new approaches to teaching genetics. From her reading and from a workshop she attended for high school teachers at the local university, she discovered that many people have been experimenting with ways to improve genetics instruction. She also found out that several computer programs are available that simulate genetics events.

Ms. J. was convinced that many important learning goals of the school's science program could be met in this course. She wanted to provide the students with opportunities to understand the basic principles of transmission genetics and to use a mental model as a tool for understanding. She wanted her students to engage in and learn the processes of inquiry as they developed their mental models. Ms. J. also wanted students to understand the effect of transmission genetics on their lives and on society—addressing a social issue that incorporates science and ethics.

Selecting an appropriate computer program was important, because simulation is the key to much of the first quarter of the course. Ms. J. reviewed several computer programs and noted common features. Each simulation allowed students to select parental phenotypes and make crosses. Offspring were produced quickly by all the programs; genotypes and phenotypes were distributed stochastically according to the inheritance pattern. With such programs, students were able to simulate many generations of crosses in a single class period.

All of the programs were open-ended and no answer books were provided to check answers. All of the programs allowed students to begin with data and construct a model of the elements and processes of an inheritance pattern. Students were able to use the model to predict the phenotypes and genotypes of future offspring and check predictions by making the crosses. Ms. J. chose one of the simulations after reviewing it carefully and considered the budget she had for supplies. Enough computers were available to permit students to work in teams of four.

Students worked in their teams to develop models of inheritance patterns during the first quarter. Ms. J obtained reprints of Mendel's original article for students to read early in the quarter. It discussed a nice model for an inheritance pattern, and students examined it as they identified elements of a mental model. In addition to using the simulations, Ms. J. wanted students to work with living organisms. She ordered the proper yeast strains, fruit flies, and Fast Plants. She had commercially prepared units in genetics using each of these organisms and adapted the units to meet the needs of the students. Each organism had advantages and limitations when used to study transmission genetics. Students worked in teams and shared with other teams what they learned from the different organisms .

During the second quarter, students focused on human genetics. Ms. J. contacted the local university to arrange for a speaker from the clinical genetics department. The speaker and Ms. J. worked together before, and she knew how well the speaker presented information on classes of inherited human disorders, human pedigree analysis, new research in genetic susceptibility to common illnesses, and the many careers associated with human genetics. Someone from the state laboratory came and demonstrated karyotyping and left some photographs so students could try sorting chromosomes to get a feel for the skill required to do this. Having students perform a karyotype gave new meaning to a phrase in the text: "the chromosome images are sorted by type."

Each student became an "expert" in one inherited human disorder, learning about the mode of inheritance, symptoms, frequency, effect on individuals and family, care, and such. Students presented their reports to the class. They worked in pairs to solve an ethical case study associated with an inherited disorder. Drawing on several articles about teaching ethical issues to children, Ms. J. created one of her own, and with the help of colleagues and the staff at the clinical genetics center, she developed several case studies from which the students developed their ethical issue papers.

Part of the case study required students to draw a pedigree. Ms. J. gathered print matter: fliers from the March of Dimes, textbooks on clinical genetics, some novels and short stories about people with inherited disorders, and articles from popular magazines. This was an ongoing effort; she collected the materials for years. She also put up posters and pictures from service organizations as well as student data charts around the room. This vignette involved a variety of strategies to stimulate the classroom and to involve students in the classroom instruction.

▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲

NORM 3

LEARNING THEORY

Exemplary teaching of mathematics and science incorporates an understanding of how learning occurs and uses that knowledge to create opportunities that foster success for all.

The exemplary teaching of mathematics and science requires an understanding that teaching is more than transmitting knowledge about subject matter. This kind of teaching involves subject matter expertise, pedagogical content knowledge, and general pedagogical knowledge. Exemplary teaching involves weaving these three areas of knowledge together to create an environment that allows a variety of learners to grow intellectually, socially, and emotionally. The process of learning is complicated and varied. The exemplary teaching involves being aware of current research on learning and applying that research so that every child in the classroom has an opportunity to succeed in math and science. When teachers are able to combine their understanding of how learning occurs with an understanding of the nature of science and mathematics, they are able to facilitate a depth of understanding among all kinds of learners.

In order to understand how learning occurs, an educator should:

- ▲ *Advocate for all learners and believe that all can learn math and science.*
- ▲ *Promote the development of all students' dispositions to do mathematics and science.*
- ▲ *Encourage students to use their extant knowledge to frame new knowledge about math and science.*
- ▲ *Create and maintain an environment that is physically and emotionally safe for asking math and science questions, posing and solving math and science problems, and conducting mathematical and scientific inquiries.*
- ▲ *Select science and mathematics content and instructional strategies to meet the interests, knowledge, and experiences of the students.*
- ▲ *Maintain a balance between hands-on and minds-on activities that encourage students' enthusiasm and conceptual development.*
- ▲ *Use a wide range of strategies to engage students in learning science and mathematics.*
- ▲ *Express a passion and an excitement for the ideas, processes, and skills involved with the nature of mathematics and science and with the learning and understanding of each discipline.*
- ▲ *Orchestrate discourse by deciding when to provide information, when to clarify an issue, when to model, when to lead, and when to let a student struggle with a difficulty.*
- ▲ *Pose questions and tasks that elicit, engage, and challenge each student's thinking about the mathematical and scientific nature of the world.*
- ▲ *Model and encourage the use of the skills of scientific and mathematical inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize scientific inquiry and mathematical problem solving.*

NORM 3

Mathematics Vignette

(Adapted from NCTM Professional Teaching Standards, pp. 42-44)

Toward the end of a unit on quadratic equations, Mr. Santos decided to assess his algebra students' use of problem-solving processes and their ability to make mathematical connections, both among ideas in the unit and between these ideas and concepts covered earlier. To do this, he chose the following problem from the *1988 NCTM Yearbook, The Ideas of Algebra, K-12* (p. 19):

Find all the values of x for which
$(x^2 -5x + 5)^{x2 - 9x + 20} = 1$

He asked students to work on the problem in pairs while he circulated among as many of the pairs so he could monitor their progress. He used a checklist with students' names on it as an efficient means of recording observations about students' thinking, approaches, and patterns of working.

The first pair of students he visited, Alan and Bettina, groaned, "This is really going to be gross!" "Look, it's got two different quadratics in the same equation!" "Yeah, it's not fair. He never gave us such a complicated one before!" "Oh, well," Bettina said, "We might as well get started. Let's factor $x^2 - 9x + 20$ and see what we get." When they found that (x-4) and (x-5) were the factors, Alan said, "Well, I guess that's it, x=4 and x=5 must be the answers."

Bettina did not seem certain about Alan's assertion. "What about this other quadratic? Don't we have to check that it works there, too?" she asked. "Oh, yeah," agreed Alan, "You check 5 and I'll check 4." So, they substituted 4 and 5 into $x^2 - 5x + 5$. Alan said, "I get 1 like I'm supposed to," but Bettina said, "I don't get 1, I get 5." This result puzzled them.

As they looked at the problem together, Alan said, "We need to use both quadratics together," and Bettina chimed in, "Yeah, it's this to that power." Evaluating the entire expression, they found that for x = 4 they got 1^0 and for x = 5 they got 5^0. They commented, "It's 1 either way; anything to the 0 power is 1."

Alan leaned back, seeming confident that they had solved the problem. Bettina, still engaged with the problem, said, "Hey, look, if this is 1, then the exponent could be anything. Can we use that?"

Taking up Bettina's question, Alan pointed at the base, $x^2 - 5x + 5$, and says, "Okay, you mean we should see if any other values of x could make this part equal to 1?"

Out of the corner of his eye, Mr. Santos noticed a pair of students clowning around by the window. He heard them laughing and saw them pushing one another playfully. He approached them and asked, "What's up?"

"No way we can do this problem, Mr. S," said Diarra.

"And, besides, who CARES?" added Tommy.

Mr. Santos guessed that part of their frustration was that the problem looked too complex. He invited them to try the problem by putting in some numbers.

"How about 1?" suggested Diarra.

"Yeah," agreed Tommy.

When they tried 1, they were surprised to see that it worked out.

"Hey, this is easy, man!" exclaimed Tommy. At this, other students crowded around.

"Are there other solutions?" asked Mr. Santos, relieved that the students were becoming engaged.

continued on next page

"I'll try 2," volunteered one. Others were trying other numbers. As he walked away, Mr. Santos heard another burst of excitement as a pair of students discovered that 2 also worked. He also heard a groan from a student who tried 0.

Looking around the classroom, Mr. Santos noticed a pair of students, Geraldo and Linnea, using a graphing calculator. When he went over to them, they told him that they had graphed the functions $Y = 1$ and $Y = (x^2 - 5x + 5)^{x^2 - 9x + 20} = 1$. They zoomed in to look for the points of intersection. When he asked them to explain what they were doing, they said that they decided from the beginning to use a graphing calculator. They described moving from graphing the two quadratics separately to using the exponentiation key to graph the whole function together. Linnea said, "We finally realized that what we had here was a polynomial to a polynomial power."

Mr. Santos asked them about the section of discontinuity on the graph and if their "picture" represented a complete graph. He suddenly realized that this pair of students had provided him with additional insight into this problem and made a mental note to change his lesson plans for later in the week. He would bring in the demonstration computer so that the whole class could participate in further discussion on using technology to solve this problem.

Mr. Santos looked around the class for another group to visit and noticed another pair, Peter and Ona who were lounging with nothing to do. "How are you two doing?" he inquired pleasantly.

"Great!" Peter replied, "We got the answer; it's 4 and 5." They showed Mr. Santos how they did it. They used an approach similar to the one used by Alan and Bettina.

Mr. Santos asked, "Didn't you just say that when $x = 4$ you got this polynomial [pointing to the base, $x^2 - 5x + 5$] to be equal to 1?" He paused, hoping that they would notice the importance of the base having the value of 1.

After some consideration, Peter said, "Yes, but we were worried more about the exponent being 0; but if the base is 1, the exponent wouldn't have to be 0." Ona said, "Okay, let's see if we can solve $x^2 - 5x + 5 = 1$. They set out to factor the $x^2 - 5x + 5$, ignoring the fact that it was not set equal to 0.

Mr. Santos glanced at his watch and noticed that the period was almost over. He decided to end the class by reminding the students to write their journal entries for the day. They had to record the problems and successes they encountered during the period, any new insights, and anything that stood out to them about other student's arguments or solutions in class. Mr. Santos also told the students that there were more than two solutions to the problem and that they would have another period to work on the problem on their own before they had a class discussion of the problem.

▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲

SCIENCE

Science Vignette

(Adapted from NSES, pp. 124-125)

George was annoyed. There was plenty of water in the watering can when he left it on the windowsill on Friday. Now the can was almost empty, and he would not have time to go to the restroom and fill it so that he could water the plants before science class started. As soon as Ms. W. started science class, George raised his hand to complain about the disappearance of the water. "Who used the water?" he asked. "Did someone drink it? Did someone spill it?" None of the students in the class had touched the watering can, and Ms. W asked what the students thought happened to the water.

Marie had an idea. If none of the children took the water, then it must have been that Willie, their pet hamster, left his cage at night and drank the water. The class decided to test Marie's idea by covering the watering can so that Willie could not drink the water. The children implemented their investigation, and the next morning observed that the water level had not dropped. The children now had proof that their explanation was correct. Ms. W. asked the class to consider alternative explanations consistent with their observations. Are they sure that Willie was getting out of his cage at night? The children were quite certain that he was.

"How can you be sure?" asked Ms. W. The children devised an ingenious plan to convince her that Willie was getting out of the cage. They placed his cage in the middle of the sand table and smoothed the sand. After several days and nights, the children observed that no footprints had appeared in the sand, and the water level had not changed. The children now concluded that Willie was not getting out of his cage at night.

"But wait," said Kahena, "Why should Willie get out of his cage? Willie can see that the watering can is covered." So the class decided to leave the cage in the middle of the sand table and take the cover off the watering can. The water level started to drop again, yet there were no footprints in the sand. Now the children dismissed the original idea about the disappearance of the water, and Ms. W. took the opportunity to give the class more experiences with the disappearance of water.

At Ms. W's suggestion, a container of water with a wide top was placed on the windowsill and the class measured and recorded changes in the water level each day using strips of paper to represent the height of the water. These strips were dated and pasted on a large sheet of paper to create a bar graph. After a few days, the students discovered a pattern. The level of water fell steadily but did not decrease the same amount each day. After considerable discussion about the differences, Patrick observed that when his mother dried the family's clothes, she put them in the dryer. Patrick noted that the clothes were heated inside the dryer and that when his mother does not set the dial on the dryer to heat, the clothes just spun around and did not dry as quickly. Patrick suggested that water might disappear faster when it is warmer.

Based on their experience of using strips of paper to measure changes in the level of water and identifying patterns of change, the students and Ms. W. planned an investigation to learn whether water disappears faster when it is warmer.

The children's experiences with the disappearance of water continued with an investigation about how the size (area) of the uncovered portion of the container influenced how fast the water disappeared and another where the children investigated whether using a fan to blow air over the surface of a container of water made the water disappear faster.

NORM 4

LEARNING ENVIRONMENT

Exemplary teaching of mathematics and science requires vibrant learning environments that encourage critical thinking and reflection.

A vibrant learning environment is one in which every child is learning. In this environment students are active participants who initiate and sustain their own journey into learning. Students ask questions, use resources freely, and offer input when deciding what will be studied. Teaching in a vibrant learning environment accommodates the diversity of all learning styles possible in the classroom. As a result there are visual, auditory, and tactile sources of information. A vibrant learning environment is interactive and alive with engaged learners and teachers.

In order for vibrant learning to occur, an educator should:

- ▲ *Collaborate with students to develop projects and learning tasks that they find relevant and challenging.*
- ▲ *Work to develop and maintain an atmosphere of trust and respect.*
- ▲ *Actively involve students in learning activities.*
- ▲ *Ask students to clarify and justify their ideas orally and in writing.*
- ▲ *Value and respect a range of communication styles and language differences.*
- ▲ *Establish a two-way dialogue about mathematical and scientific ideas.*
- ▲ *Encourage and model the skills of scientific inquiry and mathematical discovery.*
- ▲ *Pose tasks that call for problem formulation, problem solving, and mathematical or scientific reasoning.*
- ▲ *Support and encourage students to take intellectual risks by raising questions, formulating conjectures, and conducting independent inquiries.*
- ▲ *Pose tasks that represent mathematics and science as ongoing human activities.*
- ▲ *Foster the development of each student's mathematical/scientific power by providing and structuring the time necessary to explore sound mathematics/science and grapple with significant ideas and problems from these disciplines.*

NORM 4

Mathematics Vignette

(Adapted from NCTM Professional Teaching Standards, pp. 53-54)

Mrs. Martinez and Mr. Golden have teamed up to teach eighth grade and have divided their students into groups of four. They have challenged their students to show why the text says division by zero is "undefined." The teachers wanted their students to know why "you can't divide by zero." Usually, that is all the information that the students have learned. Once the students figured out why division by zero is undefined, they prepared something that they could use to justify their explanation to the rest of the class. Mrs. Martinez suggested that the calculator might be a useful tool for this problem. "Making up some kind of story problem for a situation that involves division might be helpful for others," added Mr. Golden. The two teachers arranged their large classroom so that calculators, graph paper, Unifix cubes and base ten blocks, felt-tip markers and blank overhead transparencies, rulers, and other materials were out where students could freely use them. This facilitated the use of alternative tools. Students were encouraged and expected to make decisions about which tool to use. Several students were preparing overheads to display their conclusions about division by zero. Others were excitedly punching calculator buttons.

"The answer keeps getting larger and larger!" exclaimed a pair of girls as they watched the results obtained by successively dividing 4 by smaller and smaller divisors with the calculator. "Why is that important?" asked Mrs. Martinez as she watched over one girl's shoulder. "Well, because each of the numbers we are dividing by is getting closer and closer to zero but isn't zero." "Maybe you could make a graph to show what you are finding," suggested Mrs. Martinez.

Mr. Golden found two students slouching sullenly in their chairs behind the room divider. "We don't understand what to do," grumbled one. Mr. Golden sat down next to them and said, "Let's see if I can help. You are trying to figure out what the special problem is in trying to divide by zero. Maybe you can use some things you already know about division. How do you know that 8 ÷ 2 is 4? How could you prove that if someone challenged your answer?" The students looked at him disbelievingly. He waited. Then one said, "Well, I'd just say that 4 times 2 is 8, so 8 divided by 2 has to be 4." "Can that help you at all with this problem?" asked Mr. Golden. He stood up. The students looked at one another and then began to talk. "Well, that doesn't work if you take 8 ÷ 0," Mr. Golden heard one say as he walked away.

▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲

continued on next page

NORM 4

Science Vignette

(Adapted from NSES, pp. 146-147)

The students in Ms. D.' s class are studying motion, direction, and speed. One experiment in this study was designed to enable the students to understand how and why to change one variable at a time. Ms. D. formed students into groups of four. One student, the materials manager, went to the supply table to pick up a length of string, scissors, tape, and washers of various sizes and weights. Each group was directed to use these materials to 1) construct a pendulum, 2) hang the pendulum so that it swings freely from a pencil taped to the surface of the desk, and 3) count the number of swings of the pendulum in 15 seconds. The notetaker in each group recorded the result on a class chart. Ms. D. asked the students to examine the class data. Because the number of swings recorded by each group was different, a lively discussion began about why this happened. Some suggestions included the length of the string, the weight of the washer, the diameter of the washer, and how high the student held the washer to begin the swing.

Ms. D. wrote each suggestion on the board. The class was asked to design experiments that could determine which suggestion was correct. Each group chose to do an experiment to test one of the suggestions. One group kept the string the same length but attached washers of different diameters and tried to start the swing at exactly the same place. Another group used one piece of string and one washer, but started the swing at higher and higher places on an arc. A third group cut pieces of string of different lengths, but used one washer and started the swing at the same place each time. The discussion was animated as students set up their pendulums. The class quieted down as they counted the swings. Finally, each group shared what they did and the data they collected with the rest of the class. The class concluded that the difference in the number of swings that the pendulum made was due to the different lengths of string.

The next day, students noticed that Ms. D. had constructed a board for the pendulums at the front of the room. Across the top were pegs from which to hang pendulums, and across the bottom were consecutive numbers. The notetaker from each group was directed to hang the group's original pendulum on the peg corresponding to its number of swings in a fixed time. When all of the pendulums were hung on the pegboard, the class was asked to interpret the results. The students concluded that the number of swings in a fixed time increased in a regular manner as the length of the string got shorter.

Ms. D. noted that pendulums having five or seven swings per 15 seconds were shown on the pegboard, but the class hadn't constructed a pendulum with six. She asked each group to construct such a pendulum. After much measuring and counting and serious discussion on what counted as a "swing," every group was successful. Ms. D. then asked how they could express the relationship between the length of the string and the number of swings in a form that was more convenient than the pegboard. Most students drew the pegboard with the pendulums of different lengths, but some students drew charts and a few made graphs. Ms. D. challenged students to find examples of pendulums at home and in their neighborhoods.

The next science class was spent discussing graphing as students moved from their pictures of the string lengths, to lines, to points on a graph, and to a complete graph. Finally, each student was asked to use the graph to make a pendulum that would swing an exact number of times.

NORM 5

ASSESSMENT TOOLS AND STRATEGIES

Exemplary teaching of mathematics and science includes the regular and systematic use of a variety of assessment tools and strategies so that assessment is interwoven with instruction.

For many years, the word "test" has caused great anxiety in students of all ages. When instruction and assessment are seamless, tests and other forms of assessment will no longer intimidate students because they will understand what is expected of them. They will also have opportunities to assess their own learning and determine their strengths and weaknesses. Exemplary teaching practices include varying assessment strategies in accordance with the nature of the learning expected in their classes and the nature of the material being used. This type of teaching requires clear communication about expectations and results to students, parents, and administrators at the building and district levels. In exemplary teaching, assessment is integrated seamlessly with instruction so that one informs the other.

In order to integrate assessment with instruction, an educator should:

- ▲ *Develop standards for student learning that are challenging, developmentally appropriate, and coordinated across the system.*
- ▲ *Take into account individual differences in an appropriate manner.*
- ▲ *Choose teaching and assessment strategies that help students develop understandings of math and science.*
- ▲ *Choose teaching and assessment strategies that are compatible to one another.*
- ▲ *Use multiple methods and tools and systematically gathering data about students' scientific and mathematical reasoning skills and their understandings about math and science concepts.*
- ▲ *Incorporate ongoing, embedded, diagnostic, prescriptive, and summative assessment into instruction.*
- ▲ *Provide opportunities for students to demonstrate their knowledge, understandings, and skills in a variety of ways.*
- ▲ *Use the results of assessments at different levels and in a variety of ways to improve teaching and learning.*
- ▲ *Communicate student progress to the student and his/her parent(s) or guardian.*
- ▲ *Review assessment tasks for the use of stereotypes, offensive or irrelevant language, or assumptions that reflect the perspectives or experiences of a particular group.*
- ▲ *Recognize that the purpose of an assessment may be different in different situations.*

NORM 5

Mathematics Vignette

(Adapted from NCTM Professional Teaching Standards, pp. 111-112)

The elementary principal, Barbara Moore, was very impressed with the way the second-year teacher, Ed Dudley, conducted his first-grade class and, in particular, with the way that he made extensive use of manipulatives when teaching mathematics.

She noticed, however, that when he evaluated students' progress, he relied on paper-and-pencil tests that appeared to emphasize computational outcomes. When she spoke with Mr. Dudley about this, he indicated that it just seemed like a reasonable way to evaluate students as well as a very efficient method. He indicated, however, that he is willing to try different methods of assessing students' understanding of mathematics. Ms. Moore offered several suggestions.

A week later, Ms. Moore dropped by Mr. Dudley's class to see if he tried any of the suggestions. She was pleased to see that Mr. Dudley was interviewing students in one part of the classroom. In another part of the room, pairs of students were playing a numeration game with linking cubes and a spinner to determine the number of cubes each student should receive. The students linked the cubes together whenever they had a group of ten cubes. The students took turns spinning until each had five turns. After the five spins, they wrote the total number of cubes down on a sheet of paper. Each student checked to see whether the other student had written down the correct number of cubes. Ms. Moore was impressed with the game. She planned to suggest to Mr. Dudley that the activity could provide him with an excellent means of assessing students' understanding of place value.

Ms. Moore observed one of the interviews that Mr. Dudley was conducting. She observed the following exchanges:

Mr. Dudley gave two students, Jo and Annette, a different number of counting sticks. Each student had to bundle her sticks into groups of ten.

Jo: I have 3 tens and 4 ones.
Mr. D: Is that the same as thirty-four?
(Jo hesitated. Mr. Dudley observed that she seemed unsure whether the representation of 3 tens and 4 ones also represented thirty-four.)
Annette: I think they are the same.
Jo: I don't know. Let me count them.
(Jo unbundled the sticks and began counting by ones.)
Annette: I have 4 tens and 2 ones. That's forty-two.
Mr. D: How do you know?
Annette: Look. (She pointed to bundles of ten.) Ten, twenty, thirty, forty, now (pointing to single sticks) forty-one, forty-two. See!
Mr. D: That's very good, Annette. Let's see if we can help Jo. Jo, how are you coming?
Jo: I counted and got thirty-four. They must be the same.

After Mr. Dudley finished his interviews, he discussed the class with Ms. Moore. She complimented him on assessing students' understanding in much the same way he taught mathematics. He indicated that the interviews did take some extra time but that they took less time than he had imagined. He was very pleased with how much he learned about each student's thinking about place value during the interviews. Ms. Moore helped Mr. Dudley develop a chart to make his assessment more systematic. She complimented Mr. Dudley on his willingness to try something new and how he organized the class so that all the students were involved in learning activities. She pointed out that the game could also serve as an excellent vehicle for assessing students' understanding.

▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲

NORM 5

SCIENCE

Science Vignette

(Adapted from NSES, pp. 80-81)

A seventh-grade class studied the motion of objects. One student who described his idea about motion and forces pointed to a book on the desk and said, "Right now the book is not moving." A second student interrupted, "Oh, yes it is. The book is on the desk, the desk is on the floor, the floor is part of the building, the building is sitting on the Earth, the Earth is rotating on its axis and revolving around the Sun, and the whole solar system is moving through the Milky Way." The second student sat back with a self-satisfied smile on her face. All discussion ceased.

Ms. M. signaled time and posed the following questions to the class. "Imagine an insect and a spider on a lily pad floating down a stream. The spider is walking around the edge of lily pad. The insect is sitting in the middle of the pad watching the spider. How would the insect describe its own motion? How would the insect describe the spider's motion? How would a bird sitting on the edge of the stream describe the motion of the insect and the spider?" Ms. M arranged the class to work in discussion groups. The teacher walked around the room listening to the discussions. Ms. M. asked the students to write answers to the questions she posed and suggested that the students use diagrams as a part of their responses.

The school principal observed Ms. M. during this class and asked her to explain why she had not followed her original lesson plan. Ms. M. explained that the girl had made a similar statement to the class twice before. Ms. M. realized that the girl was not being disruptive, but was making a legitimate point that the other members of the class were not grasping. So Ms. M. decided that continuing the discussion of motions and forces would not be fruitful until the class had developed a better frame of reference. Her questions were designed to help the students realize that motion is described in terms of some point of reference. The insect in the middle of the lily pad would describe its motion and the motion of the spider in terms of its reference frame, the lily pad. In contrast, the bird watching from the edge of the stream would describe the motion of the lily pad and its passengers in terms of its reference frame, namely the ground on which it was standing. Someone on the ground observing the bird would say that the bird was not in motion, but an observer on the moon would have a different answer.

▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲

NORM 6

DEMOCRATIC ENVIRONMENTS

Exemplary teaching of mathematics and science creates and sustains democratic environments by honoring individuals and cultivating community in classrooms and schools.

A democratic school environment is one in which students, teachers, parents, and all others have a voice that can be heard by those in charge. When considering the role of teachers in establishing a democratic environment, the power differential between teachers and students must be carefully considered. The process of teaching can involve using the leadership and authority of someone in a position of trust. Teachers can use these responsibilities in their classrooms to empower students to participate fully and model a democratic ideal. The pace of teaching is fast enough that a teacher's day may be consumed with the logistics of teaching, completing paperwork, and attending numerous meetings. This hectic pace may make it difficult to attend to each child as an individual. Exemplary teaching, however, requires teachers to find ways to honor and recognize each student so his or her strengths are identified and highlighted, and his or her weaknesses are identified and strengthened. At the same time, this practice requires that classrooms be models of community where each and every student is respected and has the opportunity to participate and enhance the learning of others.

In order to create a democratic environment in science and mathematics classrooms, an educator should:

- ▲ *Display and demand respect for the diverse ideas, skills, and experiences of all students.*
- ▲ *Orchestrate discourse by listening carefully to students' ideas and experiences about science, math, and classroom management.*
- ▲ *Foster the development of each student's mathematical and scientific reasoning power by respecting each student's ways of thinking and their mathematical and scientific dispositions.*
- ▲ *Orchestrate discourse among students about mathematical and scientific inquiry.*
- ▲ *Nurture collaboration through problem solving.*
- ▲ *Create flexible work environments.*
- ▲ *Provide multiple approaches for learning important foundational mathematical and scientific concepts.*
- ▲ *Facilitate discussion based on a shared understanding of the rules of scientific discourse.*
- ▲ *Select content and instruction that recognizes and responds to the range of cultural, intellectual, developmental, and emotional backgrounds that students bring to the classroom.*
- ▲ *Challenge students to accept and share responsibility for their own learning through designing their own investigations.*
- ▲ *Engage students in designing the learning environment and learning tasks and empowering them to have a voice in these decisions.*
- ▲ *Display student work.*

MATHEMATICS

Mathematics Vignette

(Adapted from NCTM Professional Teaching Standards, pp. 116-117)

A group of middle school teachers and Larry Parker, the district's mathematics coordinator, met regularly for the past semester. The group's goal was to improve the teaching and learning of various specific topics. This discussion focused on the concept of percent—a concept typically difficult for their students. Larry scheduled his visits to individual classrooms so that he could observe lessons on percent. On Wednesday afternoon he observed Betty Mathison, an experienced sixth-grade teacher.

Betty prepared transparencies of 100-square grids that were partially shaded. Each grid is shown briefly on the overhead before she asked the question, "What percent of the grid has been shaded?"

Students wrote their guesses and their reasoning on a sheet of paper. Betty walked around the room and observed what they wrote after seeing each transparency. Betty randomly selected students and asked them to indicate what their guesses were and to share their rationale for the guesses. The students started to appreciate the strategies that their classmates used.

Students gave the following reasons for their estimates:

- The first one was 36% because I saw 3 rows of ten and 6 more.
- The first one was more than 30%. I saw three rows by didn't have time to count the other ones. It was probably about 35%.
- In the second one, I think there were 8 rows of ten and then 7 more. That makes 90%. Maybe it was 86%.
- I know there was one row that wasn't shaded so it had to be less than 90%. Maybe it was 86%.
- The last one was hard. I think it was about 20%. It seemed like it was one-fourth covered.
- The third one was less than 50% but I don't know exactly. Maybe it was 10%. I'm just guessing.

Betty was supportive of the students' responses and sometimes asked them to elaborate on their reasons.

Betty paired the students to represent different percents using cardboard base-ten materials. She asked the students to represent whole number percents less than 10 and asked students how they might represent 150% or 200%, or a percentage less than 1%, like 0.5%. Larry was impressed with this extension.

Betty hoped the students would see the connection between representing percents like 36% and 87% to representing percents that are more than 100% or that are not whole number percents. She reminded the students of the earlier work they had done with decimal representations using the cardboard base-ten materials.

Both Larry and Betty were pleased with the lesson. Although the students had a great deal of difficulty representing percents greater than 100 and percents that were not whole numbers, they felt that it was a good start in developing a concept of percent. Larry asked Betty to share the lesson with the other middle school teachers at the next meeting. He wanted the other teachers to see how Betty made effective use of base-ten materials constructed from old cut-up cardboard boxes to teach percent. Larry indicated that he would try to secure funds so that the materials can be made from card stock to be more attractive for the students.

NORM 6

SCIENCE

Science Vignette

(Adapted from NSES, pp. 162-164)

Mr. S. reviewed his syllabus for the year. He saw the next unit and smiled. On Monday they would begin the "Egg Drop." The students, working in teams, would design a container for an uncooked egg. The timing was right. The students had already focused on the similarities and differences between science and technology and have completed activities and engaged in discussions demonstrating an adequate understanding of force, motion, gravity and acceleration. It was time to combine the knowledge of science principles with a design problem, to design a container that could be dropped from the second floor balcony without breaking an egg. While dropping eggs from the balcony was not part of the every day experience of the students, dropping things and having them break was.

On Monday, he set the challenge, the constraints, and the schedule. They began with a whole-class review of what the students knew about force, acceleration, and gravity and the design principles. He had a student write these on a chart that they could hang on the wall during the unit. Next, they identified things that they saw fall gently without breaking and about the size, shape, material, and construction of these items. Finally, he told the students the constraints: teams would be made up of three students each; materials would be limited to the 'stuff' available on the work table; teams would have to show him a sketch before they began building their container; and they would have to conduct at least two trials with their container, one with a plastic egg and one with a hard-cooked egg.

For years he had collected odds and ends—string, plastic, paper towels, egg cartons, Styrofoam peanuts, cotton, and other packing materials. In the world outside of school, limited availability of materials was a real constraint. He was grateful that he taught in Florida where he could open the door and watch the students outside as they climbed to the second floor balcony to conduct their trial runs. He knew that if he taught up North, where they would have to do this activity from the gym balcony, he would have to plan differently as the class would have to move to and from the gym.

On Tuesday, he had a few raw eggs for each class. He had several students try to crush them by exerting force with their hands. He used lab aprons, goggles, and plastic gloves. Then he showed the egg drop video. After the first few years, he learned to videotape the class on the day of the egg drop. He edited a short video of some of the more spectacular egg drops—both successful and unsuccessful. The students enjoyed watching older brothers and sisters, and famous and infamous students. The students got into their groups and discussed the features of the containers in which the eggs broke and those in which the eggs did not break. He challenged them to consider how they might improve the successful egg drop containers. Toward the end of the period, each group had someone report to the class one thing the group learned from the video and discussion.

Wednesday was an intense day as students argued and sketched, had plans approved, collected materials, bartered with other teams for materials, and tried to build a prototype of their container.

Thursday they began class with a discussion of why they needed to build a prototype and why they needed to do some trial runs with plastic and hard cooked eggs. He asked them the advantages and disadvantages of using the plastic and hard cooked eggs in the trial runs.

This discussion gave the students an opportunity to consider cost and characteristics of models. Class time was set aside to work and begin the field trials. Mr. S. needed a supply of trash bags to use as drop cloths.

Friday's class began with a reminder to the students that the assessment for the egg drop would not be whether the egg broke, but rather how they would be able to share what they considered as they tried to solve the problem of designing a container for an egg so that the egg could drop 15 feet and not break. He also reminded them that the egg drop was scheduled for Wednesday.

Monday was an uninterrupted workday. On Tuesday they worked in groups to determine what was needed to make their egg drop event a success. In his plans, Mr. S. noted that he needed a set-up team that would cover the ground below the balcony with trash bags. The clean up crew wore plastic gloves to gather the bags and get them into the disposal. He anticipated that the students would want two classmates to have stopwatches to measure the time it took for the egg to drop.

The students wanted to determine where the egg should be held for the start of the egg drop. There were several heated arguments about whether the starting line was from the arm of the dropper or from some point on the container. They needed someone to yell "Drop!"

Wednesday was the day of the egg drop. Thursday, the class began by meeting in their small groups to discuss what worked, what did not, why, and what they would do differently if they were to do the egg drop design experiment again. Then they discussed these same ideas as a whole class.

Friday, the students filled the board with characteristics of good design procedures. Then they wrote and sketched these characteristics and what each student learned from the egg drop activity in their notebooks. Mr. S. knew from experience that the egg drop would be an engaging activity.

Mathematics Vignette

(Adapted from NCTM Professional Teaching Standards, pp. 169-170)

Dick Richey taught mathematics in a large high school. Five years ago he was disenchanted with teaching. He was bored, his students were bored, and there did not seem to be any challenge in the job. He even considered leaving teaching.

He read about a three-year, federally-funded summer institute on the teaching of algebra in an issue of the NCTM News Bulletin in the faculty resource room. He decided to apply, but was rather apprehensive when he was selected.

During the first three-week summer session he was immediately thrust into the midst of twenty-four experienced teachers. Two university professors were determined to involve him in thinking deeply about what he was doing in his classes. Some of the content was new including using technology to teach mathematics, teaching strategies, and research on teaching and learning. Sharing and collegiality dominated their work together.

Initially, Dick was convinced that the professors were unrealistic. They gave an assignment to the group to analyze the first-year algebra curriculum. The teachers identified the "big" ideas of algebra—the ideas that were so powerful that understanding them would enable every student to do any beginning algebra problem. They were permitted to choose no more than ten "big" ideas! When their lists of "big" ideas was compiled, it was three pages long.

Over the three-year period the teachers developed lenses to look at the algebra they were teaching to help them identify central ideas. Two summers later the list had been refined to a small but significant list: real numbers, variables and functions, distributive property, equivalent fractions, and expressions and sentences.

Algebra that is organized around several key ideas has made considerable differences in Dick's teaching. He looked for connections among ideas and tried to help his students find mental hooks or organizers on which to hang new mathematical ideas. He also videotaped his classes so that he could analyze his teaching.

The continuing support and yearly visits from the professors helped Dick maintain his renewed perspective on his teaching. Throughout the program, the institute participants shared their ideas and struggles through electronic mail. In fact, this network continued and grew to include many high school teachers across the state.

The support Dick received from his principal and the district mathematics supervisor was essential to the changes Dick has made. They provided him with time to work with the other faculty in the district and to write a "Technology in Education" grant proposal to a local business. The grant provided the district with resources to buy sets of calculators and to upgrade the computers available for mathematics instruction.

Although the algebra institute ended, Dick remained in contact with the professors and many participants, personally and electronically. Their support has been particularly helpful in planning workshops that he has given in the area.

NORM 7

CONTRIBUTIONS TO THE PROFESSION

Exemplary teaching of mathematics and science includes taking the time to be reflective and to make contributions to the profession.

Teachers are professionals, not technicians. Exemplary teaching is a passion, not just a job. This type of teaching includes a level of dedication that causes teachers to reflect on what they are doing and what they are not doing. They attend to the changing character of their students and community and adjust their teaching accordingly. In this type of teaching, teachers also see their roles extending beyond their immediate classrooms.They are active as leaders of instruction, reform, and morale in their buildings, districts, and professional associations. These are the teachers who never seem to tire or lose their enthusiasm for teaching. They have lots of resources available from which to design appropriate learning experiences for their students. However, they do not expect to use the same materials in the same way with each group of students. These teachers do not want to stagnate. Instead, these teachers are constantly looking for ways to improve their interactions with the children in their classrooms and to improve the condition of education in general. This aspect of teaching is ongoing and never ending.

In order to incorporate reflective teaching practices, an educator should:

▲ *Advocate for the education profession.*

▲ *Look for ways to work with other professionals at all levels: prospective, novice, and experienced.*

▲ *Act as a bridge linking schools to the community, parents, and higher education.*

▲ *Consider the impact one's personal capabilities and limitations have on his or her role in school renewal.*

▲ *Conduct an ongoing analysis of teaching and learning.*

▲ *Work with teams of teachers to improve the teaching and learning of science and mathematics.*

▲ *Take an active role in professional development by accepting responsibility for experimenting thoughtfully with alternative approaches and strategies in the classroom.*

▲ *Participate actively in the professional community of mathematics or science educators.*

NORM 7

Science Vignette

(Adapted from NSES, pp. 234-236)

A district-level advisory committee was assigned the task of implementing science education standards. This committee included the science supervisor, six science teachers (two each from elementary, middle, and high schools), a principal, a parent, two scientists representing industry and higher education, and two university science educators. The committee reviewed the national and state model science standards and headed the development of district science standards. The standards-based science program the committee was implementing consisted of a district curriculum, a professional development plan, and a school/district-level assessment process. The committee reviewed the current K-12 standards-based science education program to identify areas needing improvement and to establish a unified view of a standards-based science program with appropriate activities and resources.

This group formed smaller groups to focus on specific tasks that coordinated resources and individual efforts to improve science education in the district. One of these focus groups interfaced with the university on aligning Continuing Education Units (CEU) courses with the standards. Another subcommittee met with the new district superintendent while the third subcommittee determined the teachers' needs for professional development.

In an effort to gain support from the university, the subcommittee noted that the district needed to stress science as inquiry, introduce authentic assessments, and support the overall standards-based movement in pre-service and professional development plans. The university could not see a reason to comply with the proposed program since the university degree programs were already approved, they met teacher certification requirements, and there was a lack of familiarity with the Standards. The committee suggested that it would seek help with their professional development from the nearby Eisenhower Consortium for Mathematics and Science at the regional laboratory. The university was persuaded by the Eisenhower Consortium director to offer in-service programs in several district schools with a professor and teacher co-leading the program. The director was able to identify exemplary curriculum materials for the teachers in the district to review.

The district superintendent's subcommittee received support to present to the board of education their plan for reallocation of funds to increase support for professional development, support for the materials to implement an inquiry-based program, and adoption of new assessments aligned with standards. During the board of education meeting, the superintendent's committee summarized its work and presented a hands-on science inquiry activity that introduced the nature of science and technology. The two middle school teachers led the activity while the other teachers showed how the activity aligned with standards, how it incorporated multiple concepts and problem-solving strategies, and how assessment was embedded into the activity. Although the board and the superintendent remained hesitant to provide full funding for professional development, they approved a pilot program in seven schools with staff who expressed strong interest in the program that would support their desire to move their curriculum and instruction into alignment with the new standards. The pilot would allow them to improve the professional development opportunities, align them with the curriculum materials being reviewed, and demonstrate that the move toward alignment with standards will improve district programs.

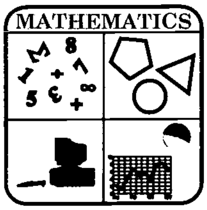
The teacher subcommittee presented a positive and encouraging report. Most of the teachers understood the importance of science education standards and appreciated their proposed roles in designing their own professional development and the science program. The teachers felt involved and that their positions were understood because they engaged in a "year of dialogue" on the National Science Education Standards and participated in the development of the district standards.

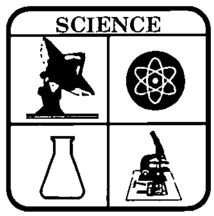
The district-level advisory committee found satisfaction in their short-term goals and noted that the common vision of groups and individuals was vital. The common vision enabled coordination among people and institutions. The strategic coordination enabled all resources to be used effectively and efficiently to support a common vision. Coordination and allocation of resources happened when individuals accepted personal responsibility and participated in a distributed leadership capacity to fulfill the vision and spirit of the standards.

▲▲▲▲▲▲▲▲▲▲▲▲▲▲▲

TOOLS

ARTICLES





	Mathematics (M), Science (S), General Education (E)	NORM 1: Nature and Teaching Theory of Discipline	NORM 2: Selection and Teaching of Content	NORM 3: Learning Theory	NORM 4: Learning Environment	NORM 5: Assessment Tools and Strategies	NORM 6: Democratic Environment	NORM 7: Contribution to the Profession
Advanced Mathematical Thinking:								
"Functions and Associated Learning Difficulties"	M	✔						
"Mathematical Creativity"	M	✔						
Affect and Mathematical Problem Solving:								
"Self-Confidence, Interest, Beliefs, and Metacognition"	M				✔			
Arithmetic Teacher:								
"Achievement Tests in Primary Mathematics: Perpetuating Lower-Order Thinking"	M					✔		
"Activating Assessment Alternatives in Mathematics"	M					✔		
"Assessing Reasonableness: Some Observations and Suggestions"	M				✔			
"Assessing Student's Beliefs about Mathematics"	M							✔
"Connecting Learning and Teaching through Assessment"	M					✔		
"Cooperative Problem Solving: But What About Grading?"	M					✔		
"Implementing the Professional Standards for Teaching Mathematics: Teaching and Learning through Classroom Discussion"	M				✔			
"Implementing the Professional Standards for Teaching Mathematics: The Role of Reflection in Teaching"	M							✔
"Implementing the Professional Standards for Teaching Mathematics: What's All This Talk about Discourse?"	M				✔			

TOOLS

ARTICLES

MATHEMATICS / SCIENCE	Mathematics (M), Science (S), General Education (E)	NORM 1: Nature and Teaching Theory of Discipline	NORM 2: Selection and Teaching of Content	NORM 3: Learning Theory	NORM 4: Learning Environment	NORM 5: Assessment Tools and Strategies	NORM 6: Democratic Environment	NORM 7: Contribution to the Profession
Arithmetic Teacher:								
"Linking Instruction and Assessment in the Mathematics Classroom"	M					✔		
"Teacher as Kimp"	M				✔			
"What Do We Have and Where Do We Go from Here?"	M		✔					
Cognitive Science and Mathematics Education:								
"What's All the Fuss about Metacognition?"	M				✔			
Educational Leadership:								
"How New Science Curriculums Reflect Brain Research"	S			✔				
ERIC document:								
"A Constructivist Vision for Teaching, Learning, and Staff Development"	M,S	✔		✔				
Hands On!:								
"Democratizing Pedagogic Practice: A View from across the Atlantic"	E						✔	
Journal for Research in Mathematics Education:								
"Equity, Mathematics Reform, and Research: Crossing Boundaries in Search of Understanding"	M						✔	
Mathematics and Cognition:								
"Psychological Aspects of Learning Early Arithmetic"	M	✔						

TOOLS

ARTICLES

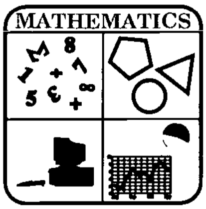
	Mathematics (M), Science (S), General Education (E)	NORM 1: Nature and Teaching Theory of Discipline	NORM 2: Selection and Teaching of Content	NORM 3: Learning Theory	NORM 4: Learning Environment	NORM 5: Assessment Tools and Strategies	NORM 6: Democratic Environment	NORM 7: Contribution to the Profession
Mathematics Teacher:								
"Connecting Research to Teaching: Making the Transition: Tensions in Becoming a (Better) Mathematics Teacher"	M			✔				
"Connections" Issue	M		✔					
"The Farther Out You Go ... Assessment in the Classroom"	M					✔		
"Implementing the Professional Standards for Teaching Mathematics: Learning from Your Students"	M			✔				
"Implementing the Professional Standards for Teaching Mathematics: The Excitement of Learning with Our Students – An Escalator of Mathematical Knowledge"	M			✔				
"The Mathematics Test: A New Roll for an Old Friend"	M					✔		
"Student Mathematics Portfolio: More than just a Display Case"	M					✔		
Phi Delta Kappan:								
"Assessment Literacy for the 21st Century"	M,S					✔		
School Science and Mathematics:								
"Contemplating Criteria for Science Education Reform: The Case of the Olympia School District"	M	✔						
Science and Education:								
"The Nature of Mathematics: Towards a Social Constructivist Account"	S							✔

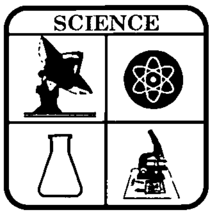
32

BEST COPY AVAILABLE

TOOLS

ARTICLES





	Mathematics (M), Science (S), General Education (E)	NORM 1: Nature and Teaching Theory of Discipline	NORM 2: Selection and Teaching of Content	NORM 3: Learning Theory	NORM 4: Learning Environment	NORM 5: Assessment Tools and Strategies	NORM 6: Democratic Environment	NORM 7: Contribution to the Profession
Science Scope:								
"Mystery Assessment"	S					✔		
"What's the Connection?"	S		✔					
The Science Teacher:								
"Classroom Volcanology"	S	✔						
"Exhibiting Excellence"	S				✔			
"Guided Thinking"	S		✔					
"A Portfolio Primer"	M,S					✔		
Teaching Children Mathematics:								
"Beyond the Classroom: Linking Mathematics Learning with Parents, Communities, and Business and Industry" Focus Issue	M							✔
"I Do and I Understand, I Reflect and I Improve"	M	✔						
"Improving Instruction by Listening to Children"	M				✔			
"Journal Writing: An Insight into Students' Understanding"	M					✔		
"Timed Tests"	M					✔		

ARTICLES

Advanced Mathematical Thinking: Kluwer Academic Publishers: Boston, MA, 1991

"Functions and Associated Learning Difficulties"
Theodore Eisenberg (Chapter 3)

Why do students have so much trouble with the concept of function, why is the concept of function so important to the foundations of mathematics? This article answers these questions and more by describing current theories that attempt to answer these types of questions. The author also looks at the historical background of functions.

"Mathematical Creativity"
Gontran Ervynck (Chapter 3)

For anyone who is interested in expanding the notions of what it means to do mathematics, this article discusses why an important part of doing mathematics is creativity. It describes the ingredients, motive power, characteristics, results, and fallibility of mathematics creativity.

Affect and Mathematical Problem Solving: Springer-Verlag: New York, NY, 1989

"Self-Confidence, Interest, Beliefs, and Metacognition"
F. K. Lester, J. Garofalo and D.L. Kroll (Chapter 6)

This chapter looks at the reality of teaching problem solving and discusses the problems one may encounter with students. Affective concerns are addressed.

Arithmetic Teacher:

"Achievement Tests in Primary Mathematics: Perpetuating Lower-Order Thinking"
Constance Kamii and Barbara Ann Lewis
May 1991 (vol. 38), pp. 4-9

This article presents research on traditional testing methods. It presents a study of eighty-seven second graders to demonstrate that achievement tests in primary school mathematics emphasize pupil's lower-order thinking.

"Activating Assessment Alternatives in Mathematics"
David J. Clarke
February 1992 (vol. 39), pp. 24-29

This article presents methods that exemplify principles of assessment that involve minimal disruption of the instructional process and do not impose additional work on the teacher. Assessment methods included are annotated class lists, student portfolios, practical test, student-constructed tests, and student self-evaluation.

"Assessing Reasonableness: Some Observations and Suggestions"
Joe Garofalo and Jerry Bryant
December 1992 (vol. 40), pp. 210-212

Part of critical thinking and reflecting is knowing how to assess the reasonableness of an answer. Students often need to be instructed in this art. This article offers five suggestions to help students assess the reasonableness of their answers. Some of these include encouraging students to ask whether their answers make sense and becoming aware of students' faulty assessment criteria.

ARTICLES

Arithmetic Teacher:

"Assessing Student's Beliefs about Mathematics"
Denise Spangler
November 1992 (vol. 40), pp. 148-152

Our beliefs about mathematics affect the way we teach. This article presents eleven open-ended questions that can be posed to students and teachers alike to assess mathematical beliefs.

"Connecting Learning and Teaching through Assessment"
Jean Moon
September 1993 (vol. 41), pp. 13-15

What would it look like for your school to work on developing assessment, teaching, and learning that was in line with the NCTM standards? This article discusses such a project involving K-3 teachers. Goals included developing assessment models and helping clarify the link between assessment and teaching. Cooperative learning was used.

"Cooperative Problem Solving: But What About Grading?"
Diana Lambdin Kroll, Joanna O. Masingila and Sue Tinsley Mau
February 1992 (vol. 39), pp. 17-23

Many teachers use cooperative learning methods during instruction but face the problem of aligning assessment techniques with that instruction. This article suggests methods for interweaving your assessment with cooperative group work.

"Implementing the Professional Standards for Teaching Mathematics: Teaching and Learning Mathematics through Classroom Discussion"
Nancy Nesbitt Vacc
April 1995 (vol. 41), pp. 225-227

This article discusses the role of group discussions in student learning of mathematics. It explores the teacher's role in discourse and provides four techniques to initiate discussion in elementary school classrooms.

"Implementing the Professional Standards for Teaching Mathematics: The Role of Reflection in Teaching"
Lynn C. Hart, Karen Schultz, Deborah Najee-Ullah and Linda Nash
September 1992 (vol. 40), pp. 40-42

This article discusses the role teacher reflection should play as envisioned by the NCTM. It also discusses the why, what, when, and how of teacher reflection practices. In particular it gives five methods on how reflection can take place.

"Implementing the Professional Standards for Teaching Mathematics: What's All This Talk about Discourse?"
Deborah L. Ball
November 1991 (vol. 39), pp. 44-48

This article explores possible outcomes of using the Professional Teaching Standards as a set of tools to construct productive conversations about teaching. In particular, it presents a discussion that took place in the author's third grade classroom with her reflections on the lesson. Effective classroom discourse can be used to aid student learning.

Arithmetic Teacher:

"Linking Instruction and Assessment in the Mathematics Classroom"
Kay Sammons, Beth Kobett, Joan Heiss and Francis Kennell
February 1992 (vol. 39), pp. 11-16

This article presents assessment techniques to help improve instruction. Included are the formative-assessment techniques of observation and questioning, diagnostic interviews, and problem-solving investigations and the summative-assessment technique of performance-based tasks. Examples are included as well as at-home activities that encourage parental partnership.

"Teacher as Kimp"
Robert M. Berkman
February 1994 (vol. 41), pp. 326-328

Sometimes the best way to get students to explain themselves better is by taking what they say literally and not adding to it with our knowledge base. This article presents a technique where, by taking on a disguise of someone who does not know about a mathematical topic or by using incorrect examples, students are encouraged to reflect upon their thinking and be more precise in their language.

"What Do We Have and Where Do We Go from Here?"
Glenda Lappan
May 1993 (vol. 40), pp. 524-526

This article discusses four aspects of mathematics instruction envisioned by the Professional Teaching Standards. The four aspects discussed are: choosing worthwhile mathematical tasks, orchestrating classroom discourse, creating a constructivist environment for learning, and analyzing students' understanding and the contribution of teacher practice to student learning. It also presents some examples of successful reform efforts.

Cognitive Science and Mathematics Education: Lawrence Erlbaum Associates: Hillsdale, NJ, 1987

"What's All the Fuss about Metacognition?"
Alan H. Schoenfeld (Chapter 8)

Schoenfeld, a leader in mathematics education research, explains what metacognition (i.e. critical thinking and reflection) is and is not, what critical thinking and reflection are to the mathematician, and why they are so important in the mathematics classroom. He describes some ground-breaking research related to the topic and leads the reader to an understanding of what it means to reflect and think critically and how to get students to do so.

Education Leadership:

"How New Science Curriculums Reflect Brain Research"
Lawrence Lowery
March 1998 (vol. 56), pp. 26 - 30

NSF-funded multisensory, laboratory-oriented science programs, including FOSS, SEPUP, and STC, use information about the way the brain constructs knowledge to enhance student learning.

ARTICLES

ERIC document:

"A Constructivist Vision for Teaching, Learning, and Staff Development"
Mary Stein and others
Eric document No. 383557

Constructivism is a widely accepted theory on how students learn. This document describes some of the prominent beliefs about how students construct knowledge or learn. After each principle is discussed, some instructional examples are included to give the reader an idea of how the principle works in the classroom.

Hands On!:

"Democratizing Pedagogic Practice: A View from across the Atlantic"
Antony Luby
Summer 1994 (vol. 48), pp. 58-63

This article describes how to implement democratic ideals in the classroom through the elements of a democratic education model that was used in Scottish schools. The model relies on reflective classroom practice, includes both structure and freedom in the learning environment, provides reproductive and productive forms of learning, and furthers the ideal of democracy through everyday classroom practice.

Journal for Research in Mathematics Education:

"Equity, Mathematics Reform, and Research: Crossing Boundaries in Search of Understanding"
December 1997

This special issue presents a collection of the research and thinking related to equity issues in school mathematics. It examines quantitative research literature to determine trends in the mathematics achievement of social groups defined along the lines of race, class, gender, ethnicity, and language proficiency. The need to produce a multicultural mathematics curriculum is described.

Mathematics and Cognition: Cambridge University Press: 1990

"Psychological Aspects of Learning Early Arithmetic"
Jacques C. Bergeron and Nicolas Herscovics (Chapter 2)

What comprises student understanding of early arithmetic? This article discusses the current theoretical views and also explains what the hidden issues are. This article is for any teacher who is wondering what is really going on when their students are trying to learn early arithmetic concepts.

Mathematics Teacher:

"Connecting Research to Teaching: Making the Transition: Tensions in Becoming a (Better) Mathematics Teacher"
Doug Jones
March 1995 (vol. 88), pp. 230-234

This article discusses research on the tensions in becoming a better mathematics teacher. They include perspectives on the nature of mathematics, conceptual and procedural knowledge, and managing competing responsibilities.

Mathematics Teacher:

"Connections" A Special Theme Issue
November, 1993.

Five of the twelve articles "illustrate applications of math" to the fields of medicine, resource management, sports, business, and consumer affairs. Another five explore the connections within math while two articles discuss strategies teachers have used with the "Connections" applications.

"The Farther Out You Go... Assessment in the Classroom"
Mark Driscoll
May 1995 (vol. 88), pp. 420-425

This article addresses that question, "Why be so careful in your assessment techniques?" It gives ways in which teachers should be careful about the assessment they are implementing. The author's basic premise is that the intended meaning and the student's constructed response are not necessarily the same.

"Implementing the Professional Standards for Teaching Mathematics: Learning from Your Students"
Margaret A. Farrell
November 1992 (vol. 85), pp. 656-659

Students will naturally develop misconceptions when they are trying to learn a concept. This article discusses the use of feedback from students and the analysis of students' error patterns to help understand why they develop those misconceptions.

"Implementing the Professional Standards for Teaching Mathematics: The Excitement of Learning With Our Students—An Escalator of Mathematical Knowledge"
Alan R. Hoffer
April 1993 (vol. 86), pp. 315-319

This article discusses the exploration and discovery aspect of mathematics. It also provides an exploration activity in which students construct computer and actual models of polyhedra and make conjectures regarding a medical research application of polyhedra involving viruses.

"The Mathematics Test: A New Role for an Old Friend"
J.R. Manon
February 1995 (vol. 88), pp. 138-141

This article discusses several ways to adapt traditional tests in new ways in order to vary assessment in the classroom.

"Student Mathematics Portfolio: More than just a Display Case"
Mary Crowley
October 1993 (vol. 86), pp. 544-547

This article describes the ways in which a portfolio may be used in a mathematics classroom. It explains what a portfolio is, what goes into one, how one can be organized, and how one might be assessed. It also includes examples of junior high school portfolios.

ARTICLES

Phi Delta Kappan:

"Assessment Literacy for the 21st Century"
Richard J. Stiggins
November 1995 (vol. 77), pp. 238-245

This article describes five standards of quality for strong assessment. Stiggins argues for educators to know clearly what they are assessing, why they are doing so, how to best assess that goal, and how to identify potential problems and prevent them.

School Science and Mathematics:

"Contemplating Criteria for Science Education Reform: The Case of the Olympia School District"
Deborah Tippins, Katherine Weiseman and Sharon Nichols
July 1998 (vol. 98), pp. 389-396

A study of the processes used in a school district to implement the Georgia Framework shows the importance of understanding socio/political forces in instituting reform.

Science and Education:

"The Nature of Mathematics: Towards a Social Constructivist Account"
Paul Ernst
January 1992 (vol. 1), pp. 89-100

This article discusses two dichotomies in the philosophy of mathematics: the prescriptive-descriptive distinction, and the process-product distinction. It then introduces the social-constructivist view, which emphasizes the importance of social interaction in the learning process, in context of the two dichotomies.

Science Scope:

"Mystery Assessment"
Mary Smith and Mary Pipal
March 1998 (vol. 22), pp. 30-33

A class team taught by a science teacher and a special needs teacher is assessed on science skills while solving a mystery.

"What's the Connection?"
Karen Parlett
February 1998 (vol. 22), pp. 30-32

A fifth-grade teacher uses constructivist teaching to help students understand that minerals in household products are the same as the minerals in rocks.

ARTICLES

The Science Teacher:

"Classroom Volcanology"
Gregory Thomas
May 1998 (vol. 65), pp. 28-31

Constructivism is used to teach students about the factors that influence eruptions, not just about volcanoes.

"Exhibiting Excellence"
Gail Carmack and Elizabeth Howard
August 1998 (vol. 65), pp. 36-39

Schools partner with informal education institutions and high school students partner with younger students to create a series of museum exhibits.

"Guided Thinking"
Victoria Ridgeway and Michael Padilla
August 1998 (vol. 65), pp. 18-21

Inquiry learning requires teacher preparation. A three-level thinking guide is used rather than a laboratory reporting exercise when students do laboratory work.

"A Portfolio Primer"
Pierette Pheeney
July 1998 (vol. 65), pp. 36-39

This article helps teachers decide what does and does not belong in a portfolio. It includes a sample global rubric for a comprehensive portfolio and one for a showcase portfolio.

Teaching Children Mathematics:

"Beyond the Classroom: Linking Mathematics Learning with Parents, Communities, and Business and Industry"
Focus Issue
February 1998

This focus issue emphasizes the importance of involving parents, communities, and others in the mathematics learning of students. It provides examples of successfully implemented projects and activities that encourage interaction between parents and schools with resources to facilitate learning at home even before a child enrolls in school. Various programs supported by business and industry to promote mathematics learning beyond the classroom is highlighted.

"I Do and I Understand, I Reflect and I Improve"
Carolyn Scheibelhut
December 1994 (vol. 1), pp. 242-246

Writing about mathematics is something we should encourage our students to do and ourselves as well. This article encourages reflection upon teaching through writing activities. It also offers suggestions on how to use students' writing, for example as a diagnostic tool and to see if students can connect mathematics to real-life situations.

ARTICLES

"Improving Instruction by Listening to Children"
Donald L. Chambers
February 1995 (vol. 1), pp. 378-380

What does it mean to listen to our students? This article gives examples of a teacher providing strategies for students to solve problems and later listening to the students' strategies. It also provides action research ideas for assessing teaching and student progress in problem solving.

"Journal Writing: An Insight into Students' Understanding"
Karen Norwood and Glenda Carter
November 1994 (vol. 1), pp. 146-148

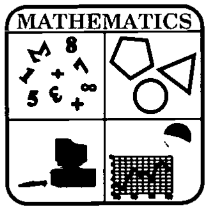
This article describes how journal writing is used to assess students' understanding of topics in progress. It contains examples of students' writing on multiplication and feelings about mathematics. Also, it gives ten suggestions for using journal writing and seventeen sample journal prompts.

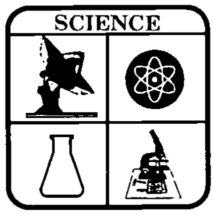
"Timed Tests"
Marilyn Burns
March 1995 (vol. 1), pp. 408-409

This article describes the importance of varied assessment techniques. It describes some of the disadvantages of timed tests.

TOOLS

BOOKS

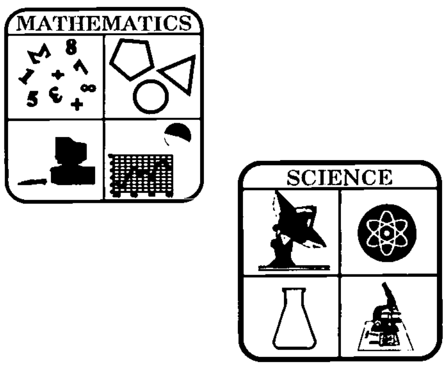




	Mathematics (M), Science (S), General Education (E)	NORM 1: Nature and Teaching Theory of Discipline	NORM 2: Selection and Teaching of Content	NORM 3: Learning Theory	NORM 4: Learning Environment	NORM 5: Assessment Tools and Strategies	NORM 6: Democratic Environment	NORM 7: Contribution to the Profession
About Teaching Mathematics	M	✔						
Active, Meaningful Mathematics Learning: A Guidebook	M			✔				✔
Active Assessment for Active Science	S					✔		
Algebra for Everyone	M						✔	
Assessment in the Mathematics Classroom: 1993 NCTM Yearbook	M					✔		
Assessment Standards for School Mathematics	M					✔		
Benchmarks for Science Literacy	M,S		✔					
Bibliography on Gender Equity in Math, Science and Technology: Resources for Classroom Teachers	M,S						✔	
Blueprints for Reform	S							✔
Celebrating Women in Mathematics and Science	M,S						✔	
Choosing Democracy: A Practical Guide to Multicultural Education	E						✔	
Classroom Assessment for Teachers	E					✔		
Connecting Mathematics Across the Curriculum: 1995 NCTM Yearbook	M		✔					
Constructivist Views on the Teaching and Learning of Mathematics	M	✔		✔	✔			
Counting on You: Actions Supporting Mathematics Teaching Standards. Perspectives on School Mathematics	M							✔
Creating Learning Experiences: The Role of Instructional Theory and Research	E		✔	✔				

TOOLS

BOOKS

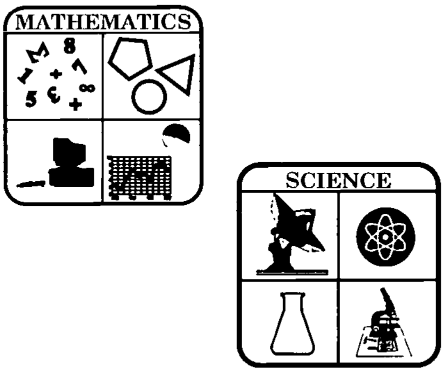
	Mathematics (M), Science (S), General Education (E)	NORM 1: Nature and Teaching Theory of Discipline	NORM 2: Selection and Teaching of Content	NORM 3: Learning Theory	NORM 4: Learning Environment	NORM 5: Assessment Tools and Strategies	NORM 6: Democratic Environment	NORM 7: Contribution to the Profession
Curriculum and Evaluation Standards for School Mathematics	M	✔	✔	✔	✔	✔	✔	✔
Democratic Discipline: Foundation & Practice	E						✔	
Democratic Teacher Education Programs, Processes, Problems, and Prospects	E						✔	
Designing Professional Development for Teachers of Science and Mathematics	M,S							✔
Dimensions of Learning	E			✔	✔	✔	✔	
Educating Everybody's Children: Diverse Teaching Strategies for Diverse Learners	E,M			✔			✔	
Educating the Other: Gender, Power, and Schooling	E						✔	
Equity: The Dialogue Among Stakeholders	M,S						✔	
Exploring Classroom Assessment in Mathematics: A Guide for Professional Development	M					✔		✔
Freedom's Plow: Teaching in the Multicultural Classroom	E						✔	
Future Basics: Developing Numerical Power	M	✔	✔					
A Guide for Reviewing School Mathematics Programs	M		✔					
Handbook of Research on Mathematics Teaching and Learning	M	✔	✔	✔	✔	✔	✔	✔
Handbook of Research on Science Teaching and Learning	S	✔	✔	✔	✔	✔	✔	✔
How to Use Cooperative Learning in the Mathematics Class, Second Edition	M		✔	✔			✔	
Inquiring Teachers, Inquiring Learners: A Constructivist Approach for Teaching	M	✔						

TOOLS

BOOKS

	Mathematics (M), Science (S), General Education (E)	NORM 1: Nature and Teaching Theory of Discipline	NORM 2: Selection and Teaching of Content	NORM 3: Learning Theory	NORM 4: Learning Environment	NORM 5: Assessment Tools and Strategies	NORM 6: Democratic Environment	NORM 7: Contribution to the Profession
In Search of Understanding: The Case for Constructivist Classrooms	S		✔	✔				
Inventing Science Education for the New Millennium	S	✔						
Lifting the Barriers	M,S						✔	
Making Sense of Secondary Science: Research into Children's Ideas	S	✔	✔					
Mathematics Assessment: Myths, Models, Good Questions, and Practical Suggestions	M					✔		
Multicultural and Gender Equity in the Mathematics Classroom: The Gift of Diversity	M						✔	
Multiple Intelligences in the Classroom	E	✔	✔	✔			✔	
National Science Education Standards	S	✔	✔	✔	✔	✔	✔	✔
New Directions for Equity in Mathematics Education	M						✔	
The Open–Ended Approach: A New Proposal for Teaching Mathematics	M		✔	✔	✔	✔	✔	
Problems of Meaning in Science Curriculum	S		✔					
Professional Standards for Teaching Mathematics	M		✔	✔	✔		✔	✔
Race, Class, Gender: An Introduction for Teachers	E						✔	
Researcher Test Manual for the Learner–Centered Battery (Grades 6–12 Version)	E			✔				✔
Research Ideas for the Classroom Volume 1: Early Childhood, Volume 2: Middle Grades, Volume 3: High School	M	✔		✔				✔
The Schoolhome: Rethinking Schools for Changing Families	E						✔	

BOOKS



	Mathematics (M), Science (S), General Education (E)	NORM 1: Nature and Teaching Theory of Discipline	NORM 2: Selection and Teaching of Content	NORM 3: Learning Theory	NORM 4: Learning Environment	NORM 5: Assessment Tools and Strategies	NORM 6: Democratic Environment	NORM 7: Contribution to the Profession
Science as a Way of Knowing: The Foundations of Modern Biology	S	✔						
Science Assessment in the Service of Reform	M,S		✔			✔		
Science "Coeducation": Viewpoints from Gender, Race and Ethnic Perspectives	S						✔	
Science Education Reform for All: A Look at How State Departments of Education are Infusing Equity and Excellence into PreK–12 Systemic Reform	S						✔	
Science for All Americans	S	✔	✔					
Science for All Cultures	S						✔	
Science Teaching Reconsidered: A Handbook	S	✔						
Scope, Sequence, and Coordination of Secondary School Science Volume II: Relevant Research	S	✔	✔					
Stages of Implementation of Standards–Led Education	M,S	✔		✔				✔
Student–Centered Classroom Assessment, Second Edition	E					✔		
A Teacher's Guide to Cognitive Type Theory and Learning Styles	E			✔				
The Teaching and Learning of Algorithms in School Mathematics	M	✔	✔	✔				
Teaching Science and Health from a Feminist Perspective	S						✔	
Toward a Scientific Practice of Science Education	S	✔						
Transforming Power: Domination, Empowerment, and Education	E						✔	

BOOKS

MATHEMATICS / SCIENCE	Mathematics (M), Science (S), General Education (E)	NORM 1: Nature and Teaching Theory of Discipline	NORM 2: Selection and Teaching of Content	NORM 3: Learning Theory	NORM 4: Learning Environment	NORM 5: Assessment Tools and Strategies	NORM 6: Democratic Environment	NORM 7: Contribution to the Profession
Turning on Learning: Five Approaches for Multicultural Teaching Plans for Race, Class, Gender, and Disability, Second Edition	E						✔	
What Children Bring to Light: A Constructivist Perspective on Children's Learning in Science	S	✔						
What Students Abroad Are Expected to Know about Mathematics, Defining World Class Standards, Volume 4	M		✔			✔		

About Teaching Mathematics
Marilyn Burns
Math Solutions Publications: Sausalito, CA, 1992

This resource addresses the challenges of teaching mathematics in the spirit of the NCTM standards. This book demonstrates why traditional math teaching, based on paper-and-pencil computation, has little relevance to the way mathematics is learned or actually used in everyday life. Teaching mathematics through problem solving is presented with classroom-tested activities.

Active, Meaningful Mathematics Learning: A Guidebook
North Central Regional Educational Laboratory: Oak Brook, IL, 1994

This booklet provides a brief overview of the National Council of Teachers of Mathematics (NCTM) standards. It also discusses some successful mathematics programs that correlate with the NCTM standards and a checklist for comparing mathematics activities in schools with NCTM standards.

Active Assessment for Active Science
G.E. Hein and S. Price
Heineman Publishing: Portsmouth, NH, 1994

This book provides examples of hands-on assessment activities for K-8 science. Many of the examples are taken from curriculum projects funded by the National Science Foundation such as Science and Technology for Children and Full Option Science System (FOSS). The authors explain how to manage hands-on assessment, how to use embedded products and activities, provide examples of rubrics and other tools for scoring, and include ideas for assessing both content and processes.

Algebra for Everyone
Edited by Edgar L. Edwards, Jr.
NCTM: Reston, VA, 1990

Each essay in this set pertains to a specific aspect of teaching the fundamentals of algebra to the entire population. It is written for anyone addressing the problem of underachieving populations.

Assessment in the Mathematics Classroom: 1993 NCTM Yearbook
Edited by Norman L. Webb
NCTM: Reston, VA, 1993

This book provides ideas and procedures for assessing the teaching and learning of mathematics in the classroom. It discusses some of the issues and perspectives regarding assessment as well as offering examples of techniques of assessment and managing assessment.

Assessment Standards for School Mathematics
The National Council of Teachers of Mathematics, Inc.
NCTM: Reston, VA, 1995

This is one of the primary documents upon which the Norms of Exemplary Teaching Practice is based. This document provides standards for assessment in the mathematics classroom. There are also vignettes and references for further reading that help to clarify the standards.

Benchmarks for Science Literacy
Project 2061—American Association for the Advancement of Science
Oxford University Press: New York, NY, 1993

This book builds on the ideas from Science for All Americans by identifying "benchmarks" that students should know and be able to do in science, mathematics, and technology at the end of 2nd, 5th, 8th, and 12th grade. The benchmarks can help teachers and curriculum developers consider the scope and sequence of science programs.

Bibliography on Gender Equity in Math, Science and Technology: Resources for Classroom Teachers
Compiled by Jo Sanders and Starla Rocco
Center for Advanced Study in Education
City University of New York Graduate Center: New York, NY, 1994

This book is a bibliography of resources related to gender equity in math, science, and technology. The resources, which include print, audiovisual, and electronic materials, provide a useful place to start considering what materials may be of use for improving gender equity in the classroom or school.

Blueprints for Reform
Project 2061—American Association for the Advancement of Science
Oxford University Press: New York, NY, 1999

This book includes short summaries of ideas for science education reform for all stakeholders in the process, including parents, policymakers, teachers, professors, administrators, and CEOs. Each chapter focuses on a different aspect of reform: equity, policy, finance, research, school organization, curriculum connections, materials and technology, assessment, teacher education, higher education, family and community, and business and industry.

BOOKS

Celebrating Women in Mathematics and Science
Edited by Miriam P. Cooney
NCTM: Reston, VA, 1996

Biographies of 22 notable female mathematicians and scientists are featured showing how their determination, creativity, and intellectual passion helped them excel in their fields. Through the personalities, the human side of mathematics is shown as well as an understanding of how they became chemists, zoologists, physicians, nurses, and mathematicians.

Choosing Democracy: A Practical Guide to Multicultural Education
Duane E. Campbell
Merrill Publishing Company: Columbus, OH, 1996

This book begins with a critical analysis of race, class, gender, and poverty as they apply to schools. After the framing information is presented, the second section provides strategies for responding to problem areas such as developing quality interpersonal relationships and empowering students of color. The third section of the book sets up a dialogue about school reform by examining textbook battles in certain stages and the Goals 2000 reform agenda.

Classroom Assessment for Teachers
Jo D. Gallagher
Merrill Publishing Company: Columbus, OH, 1998

This book emphasizes building quality assessments and learning to match important outcomes with the items and tasks used to measure them. Written for K-12 teachers who wish to update their skills in the area of assessment, this book does not emphasize any particular content area, but rather provides a strong foundation in general assessment. It thoroughly discusses a range of types of assessment including individual assessment, group assessment, portfolios, the affective domain, and paper-pencil assessments.

Connecting Mathematics Across the Curriculum: 1995 NCTM Yearbook
Edited by Peggy A. House
NCTM: Reston, VA, 1995

Some practical strategies are offered to show the power of mathematics in the classroom. The connections with mathematics, between mathematics and other disciplines, and between mathematics and the everyday world are discussed.

Constructivist Views on the Teaching and Learning of Mathematics
Edited by Robert B. Davis, Carolyn A. Mather and Nel Noddings
NCTM: Reston, VA, 1990

This fourth monograph from the Journal for Research in Mathematics Education considers the background of constuctivism, explores what it means to carry out the process of mathematical thinking, and describes how children engage in mathematical activity and how teachers can promote this activity.

Counting On You: Actions Supporting Mathematics Teaching Standards. Perspectives on School Mathematics
National Academy of Sciences - National Research Council
Mathematical Sciences Education Board: Washington, D.C., 1991

This brief document is directed to local school boards, school administrators, parents, college and university faculties, policymakers and government, business and industry leaders, and teachers. In several short sections it describes why significant change in mathematics education is necessary, what steps have been taken so far to bring about such nationwide change, and how demanding are the challenges teachers face in carrying out the task.

BOOKS

Creating Learning Experiences: The Role of Instructional Theory and Research
Bruce Joyer and Emily Calhoun
ASCD: Alexandria, VA, 1996

There is a variety of teaching models to choose from beyond lecture and recitation. This book identifies the teaching models so that the strengths and applications of each can be used to expand the instructional strategies that teachers possess.

Curriculum and Evaluation Standards for School Mathematics
The National Council of Teachers of Mathematics, Inc.
NCTM: Reston, VA, 1989

One of the primary documents upon which the Norms of Exemplary Teaching Practice is based, this document provides fifty-four standards that describe what should be in the mathematics curriculum. There are also vignettes and references for further reading that help to clarify the standards.

Democratic Discipline: Foundation & Practice
Randy L. Hoover and Richard Kindsvatter
Merrill Publishing Company: Columbus, OH, 1997

Designed primarily for use in classes about classroom management and discipline, this book is for anyone in an educational setting who wants to re-consider his/her approach to discipline from a democratic ideal. The foundations and principles of democratic citizenship are articulated and related to classroom discipline in order that every discipline-related act is informed by democratic principles.

Democratic Teacher Education Programs, Processes, Problems, and Prospects
Edited by John M. Novak
State University of New York Press: Albany, NY, 1994

This book focuses on the struggles one may face when trying to implement democracy in the classroom. There are three sections: Programs, Processes and Prospects. The first section is relevant for staff development.

Designing Professional Development for Teachers of Science and Mathematics
Susan Loucks-Horsley, Peter W. Hewson, Nancy Love and Katherine E. Stiles
Corwin Press Inc: Thousand Oaks, CA, 1998

This book is a primer on the principles of effective professional development. It presents images of what is possible and offers a design framework, many strategies, and resources for professional learning. It also discusses issues, such as equity and diversity, in designing programs and the factors influencing professional development.

Dimensions of Learning
Robert Marzano and Debra Pickering
ASCD: Alexandria, VA, 1992

Dimensions of Learning is a comprehensive model of learning that reflects the best research and theory about learning. The purpose of the model is to help pre-K-12 educators increase their own understanding of the learning process and of the nature of knowledge. With this understanding, they should be able to plan instruction, develop curriculum and design assessments that will enhance and measure student learning. The Dimensions of Learning model encompasses five critical components of learning: maintaining positive attitudes and perceptions; acquiring and integrating knowledge; extending and refining knowledge; using knowledge meaningfully; and developing productive habits of mind.

BOOKS

Educating Everybody's Children: Diverse Teaching Strategies for Diverse Learners
Edited by Robert W. Cole
ASCD: Alexandria, VA, 1995

This book provides 80 strategies to increase achievement in reading, writing, mathematics, and oral communication with 20 of the strategies for culturally, ethnically, and linguistically diverse students. The strategies include several ways to involve students actively in lessons; use thematic, interdisciplinary curriculums; and accommodate students' individual learning styles.

Educating the Other: Gender, Power, and Schooling
Carrie Paechter
Falmer Press: Hamden, CT, 1998

This book examines how girls are treated in school and raises questions about the subordination of girls in the school system. Though this book is written from the perspective of schools in the United Kingdom, it provides thought for United States teachers and administrators by challenging some of the ideas and assumptions of our educational system.

Equity: The Dialogue Among Stakeholders
Developed by CONNECT, Colorado Statewide Systemic Initiative for Mathematics and Science
Denver, CO, 1997

This pamphlet articulates what it means to include all students in mathematics and science education. There is a definition of equity that includes ideas for checking ones own practice. The role of on-going dialogue in which equity issues are continuously examined and addressed is described. There are two pages of questions with which to prompt dialogue and a list of resources to support these discussions.

Exploring Classroom Assessment in Mathematics: A Guide for Professional Development
Deborah Bryant and Mark Driscoll
NCTM: Reston, VA, 1998

This book presents an assessment framework that helps teachers obtain accurate and relevant data about what students know and are able to do in mathematics. Teachers are guided through steps such as deciding the purpose of the assessment, gathering evidence of student learning, interpreting evidence to analyze the validity of the task, and using data about students' learning to decide on appropriate instructional interventions. Six workshop activities illustrate how to plan assessments, make observations, and develop tasks and rubrics that yield results.

Freedom's Plow: Teaching in the Multicultural Classroom
Edited by Theresa Perry and James W. Fraser
Routledge Press: New York, NY, 1993

The seventeen chapters in this volume provide resources for people seeking to build fully democratic schools and to make the schools agents of democracy. The chapters are organized into four sections. These writings of teachers from different ethnic and racial backgrounds lend insight into what it means to be part of the traditionally underrepresented.

Future Basics: Developing Numerical Power
Randall Charles and Joanne Lobato
NCTM: Reston, VA, 1998

This monograph from the National Council of Supervisors of Mathematics defines numerical power, presents activities and instructional practices, and responds to questions and concerns in order to initiate a shift from paper-and-pencil algorithms to development of numerical power in the K-7 mathematics classroom. Recommendations are made as to what age level certain skills should be mastered or delayed.

BOOKS

A Guide for Reviewing School Mathematics Programs
Edited by Glendon W. Blume and Robert F. Nicely, Jr.
NCTM: Reston, VA, 1991

This book is for those who want to know where their school mathematics program stands and where it should go in the current age of reform. It is designed to enable school district personnel to analyze their mathematics programs and to explore directions for change.

Handbook of Research on Mathematics Teaching and Learning
Edited by Douglas A. Grouws
Macmillan Publishing Company: New York, NY, 1992

This book is dedicated to discussing issues in mathematics education and the research that has been done to explore them. There are 29 chapters divided into five parts: overview, mathematics teaching, learning from instruction, critical issues, and perspectives. The following chapters are of particular interest to the Norms of Exemplary Teaching Practice:

Norm 1:	Chapters 2, 6
Norm 3:	Chapters 4, 17
Norm 4:	Chapter 15
Norm 6:	Chapters 22 and 25
Norm 7:	Chapters 8, 29

Handbook of Research on Science Teaching and Learning
Edited by Dorothy L. Gabel
Macmillan Publishing Company: New York, NY, 1994

This book is dedicated to discussing issues in science education and the research that has been done to explore them. There are nineteen chapters divided into five parts: teaching, learning, problem solving, curriculum, and context. The following chapters are of particular interest to the Norms of Exemplary Teaching Practice:

Norm 1:	Chapter 15
Norm 2:	Chapter 13
Norm 3:	Chapters 4, 5, 6, 18, 19
Norm 4:	Chapter 17
Norm 5:	Chapter 14
Norm 6:	Chapters 18 and 19

How to Use Cooperative Learning in the Mathematics Class, Second Edition
Alice F. Artzt and Claire M. Newman
NCTM: Reston, VA, 1997

This edition of the book presents many new classroom-tested ideas and techniques incorporating cooperative learning approaches into the mathematics classroom. Through research, cooperative learning is essential if students are to be able to construct their own knowledge. An updated bibliography is included.

Inquiring Teachers, Inquiring Learners: A Constructivist Approach for Teaching
Catherine Twomey Fosnot
Teachers College Press: New York, NY, 1989

This book has examples of teachers who made a choice to teach in a manner that was different from how they were taught. This issue is addressed primarily by looking at teacher education and asking how can it be changed to empower future teachers to use more constructivist approaches. The work is based on experiences working with pre-service teachers from mathematics and language arts. This book is a resource for those evaluating their teacher education program.

BOOKS

In Search of Understanding: The Case for Constructivist Classrooms
Jacqueline Grennon Brooks and Martin G. Brooks
ASCD: Alexandria, VA, 1993

Students think, explore, and develop their own understandings in a constructivist classroom. This book explains how to focus curriculum on themes, pose thought-provoking problems and questions, use primary resources and manipulatives, and encourage discussion and elaboration.

Inventing Science Education for the New Millenium
Paul DeHart Hurd
Teachers College Press, New York, NY, 1997

In this book, the discourse of late twentieth centry science education is reviewed. Major issues for teaching science in the new millennium are addressed through four major questions:

- How has society moved from an industrial age to a knowledge-intensive era?
- How will science education change and develop as we move past the year 2000?
- What are the rapid changes in our society that make learning to learn a major goal of science education?
- How can we redirect science teaching beyond the laboratory and into an everyday world where science and technology are a major part of students' lives?

Lifting the Barriers
Jo Sanders
Jo Sanders Publications: Port Washington, NY, 1994

This book describes 600 tested strategies for increasing the participation of girls in science, mathematics, and computer classes. The strategies are organized into areas such as contests, counselors, curriculum, materials, field trips, parents, policies, scheduling, and teaching techniques. There is also a short list of resources at the back of the book. The ideas in this book will help teachers increase the participation of all students in the classroom.

Making Sense of Secondary Science: Research into Children's Ideas
Rosalind Driver, Ann Squires, Peter Rushworth and Valerie Wood-Robinson
Routledge Press: New York, NY, 1994

The chapters in this book provide a summary of the ideas children have about twenty-four different areas of science. The research summaries are organized into sections by life, earth, and physical science. The research was conducted in Leeds, England by the Children's Learning in Science Research Group. This resource encourages thinking about how to teach particular topics or considering the sequencing of the science curriculum.

Mathematics Assessment: Myths, Models, Good Questions, and Practical Suggestions
Edited by Jean Kerr Stenmark
NCTM: Reston, VA, 1991

This book supplies assessment models adapted from those used by other teachers, as well as step-by-step instructions on how to use portfolios and many other techniques in grades K-12.

Multicultural and Gender Equity in the Mathematics Classroom: The Gift of Diversity
Edited by Janet Trentacosta
NCTM: Reston, VA, 1997

This book demonstrates how mathematics can be made accessible to all students through the numerous ideas for providing K-12 mathematics programs for students of any race, ethnicity, language, gender, or socioeconomic situations. Examples are provided for refining the curriculum, instructional strategies, and assessment practices to promote equity in the classroom as well as professional development activities.

BOOKS

Multiple Intelligences in the Classroom
Thomas Armstrong
ASCD: Alexandria, VA, 1994

This book translates the concepts from multiple-intelligence theory into ideas and strategies to use with students, in the curriculum, and in professional development. There are sample lessons, teaching strategies, and ideas for how to present the concept of multiple intelligences to others.

National Science Education Standards
National Research Council
National Academy Press: Washington, D.C., 1996

This is one of the primary documents upon which the Norms of Exemplary Teaching Practice is based. This document describes standards for teaching, professional development, content, assessment, programs, and systems. In addition to describing the standards, there are vignettes and references for further reading in every section.

New Directions for Equity in Mathematics Education
Edited by Walter G. Secada, Elizabeth Fennema and Lisa Byrd Adajian
NCTM: Reston, VA, 1994

This collection of essays examines equity inside the mathematics classroom. It explores numerous issues including ethnic and linguistic minorities, social class, gender, and teacher empowerment.

The Open-Ended Approach: A New Proposal for Teaching Mathematics
Edited by Jerry P. Becker and Shigeru Shimada
NCTM: Reston, VA, 1997

This book reports on methods of evaluating higher-order thinking in school mathematics using open-ended problems. The implications for improving assessment and problem solving are aspects that are investigated. Lessons based on solving open-ended problems have a potential for improving teaching and learning. Examples of open-ended problems at various grade levels are included.

Problems of Meaning in Science Curriculum
Edited by Douglas A. Roberts and Leif Östman
Teachers College Press: New York, NY, 1998

This collection of essays examines the selection, production, and expression of meaning offered to students by school science curriculum. The 13 authors represent five different countries to allow a breadth of ideas. The various essays discuss policy, textbooks, classroom discourse, and curriculum renewal in light of the National standards in the United States.

Professional Standards for Teaching Mathematics
The National Council of Teachers of Mathematics, Inc.
NCTM: Reston, VA, 1991

This is one of the primary documents upon which the Norms of Exemplary Teaching Practice is based. This document describes standards for teaching mathematics, evaluation the teaching of mathematics, and the professional development of mathematics teachers. There are also vignettes and references for further reading that help to clarify the standards.

BOOKS

Race, Class, Gender: An Introduction for Teachers
Chris Gaine and Rosalyn George
Falmer Press: Hamden, CT, 1998

This book summarizes the research related to the issues of education and social inequality. Strategies for organizing staff development, working with children, and developing school policy to attend to issues of equity are described.

Researcher Test Manual for the Learner-Centered Battery (Grades 6-12 Version)
Barbara I. McCombs, Patricia A. Lauer and Audrey Peralez
McREL: Denver, CO, 1997

How can middle and high school teachers increase their impact on the learning and achievement of all students? The Learning-Centered Battery (LCB) is a set of self-assessment tools for teachers and their students that can help teachers identify their beliefs, practices, and discrepancies between teacher and student perspectives. Feedback from the LCB helps teachers identify areas of potential change and take responsibility for their own professional development.

Research Ideas for the Classroom Volume 1: Early Childhood Mathematics, Volume 2: Middle Grades Mathematics, Volume 3: High School Mathematics
Edited by Sigrid Wagner
NCTM: Reston, VA, 1993

These three volumes present the most comprehensive interpretation available of research on mathematics teaching from early childhood through high school. The research done on mathematics teaching is reviewed and summarized. Some ways to apply the research in the classroom is also presented.

The Schoolhome: Rethinking Schools for Changing Families
Jane Roland Martin
Harvard University Press: Cambridge, MA, 1992

This book is focused on education in general. It provides the foundation to consider how to honor individuals and build community in the classroom through the examination of reform movements from the past. The reform movements from the past are examined particularly the work of Maria Montessori, where school had a home-like atmosphere, and teachers took the responsibilities of teaching more than academics. These selected reform ideas are related to the needs of families in the nineties.

Science as a Way of Knowing: The Foundations of Modern Biology
John A. Moore
Harvard University Press: Cambridge, MA, 1993

This book is a collection of essays that can be read in order or individually. The first part recounts the history of views of nature, going as far back as the cave dwellers to examine the antecedents of scientific thought. The remaining parts recount the historical development of major organizing principles of biology: evolution, genetics, and development.

Science Assessment in the Service of Reform
Edited by G. Kulm and S.M. Malcom
AAAS: Washington, D.C., 1991

This book is a collection of articles that review and discuss assessment in terms of policy issues, curriculum reform, and instruction. There are 11 examples of math and science assessments in the appendix.

BOOKS

Science "Coeducation": Viewpoints from Gender, Race and Ethnic Perspectives Monograph #7
Edited by Dale R. Baker and Kathryn Scantlebury
National Association for Research in Science Teaching: Columbus, OH, 1995

This collection of 15 research papers presents a variety of evidence of the teaching strategies, curriculum materials, and assessment tools that make both positive and negative differences in the learning of science for girls and children of color.

Science Education Reform for All: A Look at How State Departments of Education are Infusing Equity and Excellence into PreK-12 Systemic Reform
Yolanda S. George and Virginia V. Van Horne
AAAS: Washington, D.C., 1996

This report looks at the case studies of three states (Florida, Michigan, and South Dakota) that have made efforts in the area of improving equity in science education. The report includes many ideas about what worked and what did not in each situation.

Science for All Americans
Project 2061—American Association for the Advancement of Science
Oxford University Press: New York, NY, 1990

This book presents recommendations for science literacy. The authors begin by describing key ideas about the nature of science and mathematics. Next they outline the concepts from the physical and life sciences that are foundational for science literacy. The later portions of the book describe key ideas about mathematics as they relate to science, principles of the designed world, historical perspectives from science, common themes across science, and the habits of mind essential to science. There are also short chapters outlining affecting learning and teaching and the need for reform in science education.

Science for All Cultures
Compiled by Shelley J. Carey
NSTA: Washington, D.C., 1993

This book is a collection of articles that have appeared in the National Science Teachers of America journals. Each article focuses on multicultural science education by highlighting the contributions to scientific thought of non-European cultures and individuals. There are ideas for grades K-12.

Science Teaching Reconsidered: A Handbook
National Research Council
National Academy Press: Washington DC, 1997

The eight chapters in the book cover general principles of teaching as well as specific methods. There is background information on misconceptions as well as ideas about evaluation, testing, and grading.

Scope, Sequence, and Coordination of Secondary School Science Volume II: Relevant Research
Edited by Marcia K. Pearsall
NSTA: Washington, D.C., 1992

This book provides readers with background research related to the Scope, Sequence, and Coordination project by National Science Teachers Association. The individual readings are relevant to anyone interested in the research about learning. There are individual chapters by different authors focused on different aspects of learning such as the relationship between content and learning, cooperative learning, equity, and constructivism.

Stages of Implementation of Standards-Led Education
Educational Commission of the States: Denver, CO, 1997

This pamphlet shows a chart of the various stages of implementing standards-led education beginning with the maintenance of non-standards-led education. The chart stimulates discussion and planning by providing a mechanism for examining where one is in the process of standards-led education in terms of public engagement, standards, curriculum and instruction, professional development, assessment, higher education, and equity.

Student-Centered Classroom Assessment, Second Edition
Richard J. Stiggins
Merrill Publishing Company: Columbus, OH, 1997

This book has four sections: Understanding the Classroom Assessment Context, Understanding Assessment Methods, Classroom Applications, and Communicating about Student Achievement. The chapters within each section include exercises to extend or stretch the reader's knowledge, reasoning, and dispositions.

A Teacher's Guide to Cognitive Type Theory and Learning Styles
Carolyn Mamchur
ASCD: Alexandria, VA, 1996

This book introduces 16 types of learners and explains curricular and instructional approaches for each type.

The Teaching and Learning of Algorithms in School Mathematics
Edited by Lorna J. Morrow
NCTM: Reston, VA, 1998

This book addresses questions about algorithms, their relevance, and their use in school mathematics at all levels through the issues concerning algorithms, the history of algorithms, and the use of algorithms in the elementary, middle, and secondary grades. Capsule lessons in alternative algorithms for the classroom as well as cultural and historical issues related to the development of algorithms and their impact on society are discussed in the book.

Teaching Science and Health from a Feminist Perspective
Sue V. Rosser
Pergamon Press: New York, NY, 1986

This guide focuses primarily on biology and health topics as they are taught at the secondary and college levels. It examines the traditional way the content in biology is organized and who is left out in that organization. A continuum of feminist approaches to the teaching of biology and health is described with sample course descriptions, teaching methods, and course syllabi.

Toward a Scientific Practice of Science Education
Edited by Marjorie Gardner, James G. Greeno, Frederick Reif, Alan H. Shoenfeld,
Andrea DiSessa and Elizabeth Stage
Lawrence Erlbaum Associates: Hillsdale, NJ, 1990

This book is a collection of articles by different authors, organized into four sections. Part One examines the research on science learning from the perspective of the disciplines (biology, chemistry, and physics). Part Two focuses on instructional design and the research that indicates what effective approaches might be. Part Three studies the social contexts of learning science by looking at the connections between school and out-of-school contexts. Part Four looks at the impact of technology on science teaching.

BOOKS

Transforming Power: Domination, Empowerment, and Education
Seth Kreisberg
Albany State University of New York Press: New York, 1992

This book examines the nature of power in the classroom, school system, and society. It also analyzes the empowerment of teachers and students to establish democracy and equity issues.

Turning on Learning: Five Approaches for Multicultural Teaching Plans for Race, Class, Gender and Disability, Second Edition
Carl A. Grant and Christine E. Sleeter
Merrill Publishing Company: Columbus, OH, 1997

This book is written for teachers who want to address difficult issues such as stereotyping by race, class, or gender directly in the classroom. Each chapter reviews the history and research background for the focus topic, then offers action research activities to conduct in the classroom to determine the level at which the issue exists. The chapter also includes a number of lesson plans for use with K-12 students covering many content areas that can be adapted to fit in any setting.

What Children Bring to Light: A Constructivist Perspective on Children's Learning in Science
Bonnie Shapiro
Teachers College Press: New York, NY, 1994

This book is a resource for those interested in knowing more about the historical development of constructivism. The book includes six case studies that provide examples of how different teachers have incorporated constructivist approaches into their teaching. In the third part of the book, the author delves into the implications of using constructivism in the classroom.

What Students Abroad Are Expected to Know about Mathematics, Defining World Class Standards, Volume 4
Co-sponsored by the American Federation of Teachers and the National Center for Improving Science Education
NCTM: Reston, VA, 1997

This book gives information about what students in other countries are expected to learn and what kinds of exams they must take. It provides some of the nationwide exams given to some students and country profiles that help explain the role the exams play in the country.

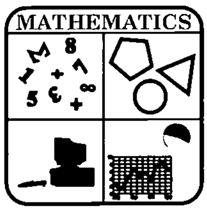
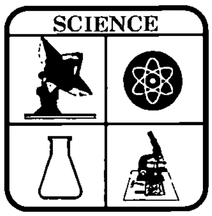
MEDIA

MATHEMATICS / SCIENCE	Mathematics (M), Science (S), General Education (E)	NORM 1: Nature and Teaching Theory of Discipline	NORM 2: Selection and Teaching of Content	NORM 3: Learning Theory	NORM 4: Learning Environment	NORM 5: Assessment Tools and Strategies	NORM 6: Democratic Environment	NORM 7: Contribution to the Profession
Algebra for Everyone (videotape, guide)	M		✔		✔		✔	
Assessment in Elementary Science (videotapes, guides)	S					✔		
Assessment in Math and Science: What's the Point? (videotape series)	M,S		✔		✔	✔		
Attaining Excellence: A TIMSS Resource Kit (videotapes, guides)	M,S	✔	✔		✔	✔		✔
Benchmarks for Science Literacy (software)	M,S		✔					
For Our Students, For Ourselves (videotapes)	E			✔	✔		✔	
http://cresst96.cse.ucla.edu (Web site)	M,S					✔		
http://equity.enc.org (Web site)	M,S	✔	✔	✔	✔	✔	✔	✔
http://mathforum.org (Web site)	M		✔					
http://inet.ed.gov/pubs/OR/ConsumerGuides/perfasse.html (Web site)	M,S					✔		
http://nces.ed.gov/nationreportcard/sampleq/index.shtml (Web site)	M,S					✔		
http://project2061.aaas.org (Web site)	M,S		✔					
http://www.enc.org (Web site)	M,S	✔	✔	✔	✔	✔	✔	✔
http://www.exemplars.com (Web site)	M,S					✔		
http://www.ncrel.org/sdrs/pathways.htm (Web site)	M,S	✔		✔				✔
http://www.nctm.org (Web site)	M		✔					✔
http://www.nsta.org (Web site)	S		✔					✔
http://www.pbs.org/teachersource/math (Web site)	M		✔			✔		✔
http://www.pbs.org/teachersource/science (Web site)	S		✔			✔		✔

58

BEST COPY AVAILABLE

MEDIA

 	Mathematics (M), Science (S), General Education (E)	NORM 1: Nature and Teaching Theory of Discipline	NORM 2: Selection and Teaching of Content	NORM 3: Learning Theory	NORM 4: Learning Environment	NORM 5: Assessment Tools and Strategies	NORM 6: Democratic Environment	NORM 7: Contribution to the Profession
http://www.scu.edu.au/schools/sawd/ari/ar.html (Web site)	E							✔
Just Think: Problem Solving Through Inquiry (videotapes)	S	✔			✔	✔		
Learning about Teaching: An Interactive Tutorial Program to Facilitate the Study of Teaching (CD–ROM, book)	M	✔		✔				✔
Mathematics Assessment: Alternative Approaches (videotape, guide)	M					✔		
Mathematics: What's the Big Idea? (videotapes)	M	✔	✔	✔	✔			✔
Project T.I.M.E. (Teachers Improving Mathematics Education) (videotape)	M							✔
Resources for Science Literacy: Professional Development (CD–ROM)	S	✔	✔					
The Science of Teaching Science (videotape)	S	✔		✔	✔			✔
Science Standards: Making Them Work for You (videotapes, guides)	S		✔	✔	✔	✔		
Shortchanging Girls, Shortchanging America (videotape)	M,S			✔			✔	
Understanding Teaching: Implementing the NCTM Professional Standards for Teaching Mathematics (CD–ROM)	M	✔		✔	✔			✔
Valuing Diversity in Children's Learning: Making It Happen in Our Schools (audio tape)	M,S					✔		
Video Case Studies in Science Education (videotapes)	S							✔
What Matters Most: Teaching for America's Future (videotape)	M,S							✔

MEDIA

Algebra for Everyone
David J. Glatzer and Stuart A. Choate
NCTM, 1992

This video provides a glimpse into an equitable classroom where small-group collaboration and the use of manipulatives are used to illustrate abstract concepts, exploration, and experimentation. The guide provides discussion materials and related activities that can be used by educators who will teach students with a history of low academic achievement and students who are part of our under-served populations.

Assessment in Elementary Science
Judy Famellette and Loraine Corfield
ASCD, 1997

Performance-based assessments are used to guide classroom practice, provide more opportunities for learning, and evaluate student and school performance. Portfolios, experiments, rubrics, and other techniques for measuring and reporting on students' ability to think and reason scientifically are provided through classroom settings.

Assessment in Math and Science: What's the Point?
Annenberg/CPB Project, 1997

K-12 math and science teachers can explore current assessment issues and strategies for improving assessment in their classrooms in this eight-part series. The workshops combine video segments from professional development libraries with suggestions and discussions by practicing teachers and content experts. Teachers hear how their peers in similar situations deal with familiar issues as well as incorporating math and science ideas into their professional growth.

Attaining Excellence: A TIMSS Resource Kit
National Center for Education Statistics (NCES), 1997

The multimedia Resource Kit includes a guide to the kit and four modules. The U.S. Education module presents an overview of the TIMSS findings through publications and video. The Student Achievement module makes the findings of TIMSS relevant to local decision-makers, educators, and parents. The Teaching module uses videotapes of actual eighth-grade mathematics lessons from the United States, Japan, and Germany to demonstrate the differences and similarities in teaching styles and techniques of educators in these countries. The Curricula module features a guidebook to help those involved in curriculum selection evaluate their own offerings through the use of curriculum analysis models, frameworks, and standards.

Benchmarks for Science Literacy
Project 2061
American Association for the Advancement of Science (AAAS)
Oxford University Press, 1995

This software (available in DOS, Windows, and Macintosh formats) enables users to browse, assemble, and print benchmarks in a variety of formats so they can personalize the use of the document for curriculum planning. The software also makes instant cross-references between related chapters and the educational research on which the benchmarks for a particular section are based.

MEDIA

For Our Students, For Ourselves
Barbara L. McCombs and Audrey Peralez
Indiana University, 1997

Adopting learner-centered practices enhances student motivation and achievement but the adoption is not always easy or smooth. This program consists of a two-part user manual with accompanying videotapes and viewer guides. Part 1 demonstrates the research-based principle developed by the American Psychological Association in three different high schools. Part 2 portrays the principles of change for teachers, students, and staff members as they gradually adopt learner-centered practices.

http://cresst96.cse.ucla.edu

Funded by the U.S. Department of Education, the National Center for Research on Evaluation, Standards, and Student Testing (CRESST) conducts research on important topics related to K-12 educational testing. The Web site includes recent articles, sample assessments and a parent page that contains assessment information relevant to parents of K-12 age children.

http://equity.enc.org

This Web site is intended to serve as a resource for those concerned about educational equity related to K-12 math and science education. Divided into primary content categories, the site demonstrates innovative programs, real-life stories, reflection questions, professional development articles and Internet sources. Resources to help educators address equity issues in their school communities as well as materials to help educators reflect on their own beliefs about equity are incorporated in the categories.

http://mathforum.org

This Web site is funded by the National Science Foundation. It organizes many Internet/Web resources for mathematics educators and acts as a "gateway" to this useful information by providing links to relevant sites. It also provides some original material for use in the classroom.

http://inet.ed.gov/pubs/OR/ConsumerGuides/perfasse.html

The address is the September 1993 Consumer Guide for Performance Assessment. An overview of the characteristics of performance assessment with a rationale about why one might want to use performance assessment is provided as well as a brief synopsis of the research about this type of assessment. There are no examples of performance assessments at this site, however, they do list several projects and experts to contact for more information at the end of the consumer guide.

http://nces.ed.gov/nationreportcard/sampleq/index.shtml

This Web site offers released items from the National Assessment of Educational Progress (NAEP) in mathematics and science in grades 4, 8, and 12.

http://project2061.aaas.org

This Web site provides a means for finding out about current activities of Project 2061. This project is an on-going part of the American Association for the Advancement of Science that emphasizes excellence in science education. This site will include comprehensive reviews of curriculum materials for middle school science and mathematics.

http://www.enc.org

This one-stop site can be used to locate products, services, resources and materials that are available for mathematics and science educators. The lessons, activities, articles and Web sites that are provided at this site allows teachers to increase their effectiveness.

http://www.exemplars.com

This site will assist teachers, schools and districts in implementing authentic assessment and problem solving by providing high quality teacher-developed and classroom-tested assessment problems in mathematics and science. Each problem comes with rubrics based on national standards; benchmark papers are also included.

http://www.ncrel.org/sdrs/pathways.htm

This site contains three multimedia essays (Realizing New Learning for All Students Through Professional Development, Find Time for Professional Development, and Evaluating Professional Growth and Development) that address critical issues in professional development, offering a range of supporting information for administrators, teachers, and others. The essays use case descriptions to focus on schools that have implemented comprehensive programs to support educational reform.

http://www.nctm.org

This Web site is provided by the National Council of Teachers of Mathematics. It provides access to the NCTM standards, publications, classifieds, and meetings schedule. It also provides access to external link sites which contain related mathematics education materials.

http://www.nsta.org

This Web site is provided by the National Science Teachers Association. It provides valuable information to all science teachers as well as links to various sites on the Internet.

http://www.pbs.org/teachersource/math

This site provides several resources for the mathematics teacher. These include: math concepts, teaching tips, math challenges, career connections, assessment, and resources. Career connections provides profiles of real people and how they use mathematics in their jobs. Math concepts provides student activities for the classroom.

http://www.pbs.org/teachersource/science

This site provides several resources for science teachers. It is the central location for Scienceline communications as well as PBS offerings.

http://www.scu.edu.au/schools/sawd/ari/ar.html

This Web site focuses on school-based action research. Tips for conducting research as well as descriptions of resources are included.

Just Think: Problem Solving Through Inquiry

New York Education Department
Office of Educational Television and Public Broadcasting

There are seven videotapes in this series: Inquiry, Design, Starts, Discourse, Research, Assessment and Partnerships, that are available individually or as a set. Scientific inquiry is the foundation in each of the videotapes, which shows it as a complex process of problem solving, the problem-solving process in technology and how to get started. The videotapes also model the role of group communication, reveals the challenges of developing explanations, and focuses on performance-based assessment. The videotapes also encourage the development of partnerships among educators, parents, and community members.

Learning about Teaching: An Interactive Tutorial Program to Facilitate the Study of Teaching
Judith Mousley and Peter Sullivan
NCTM, 1996

The user becomes immersed in an Australian Year 6 classroom to experience the multidimensionality of teaching through activities such as viewing classroom vignettes, discussing reactions to various questions, and posing and exploring research questions. The book contains instructions and activities to support the interactive CD-ROM.

Mathematics Assessment: Alternative Approaches
Project directed by Therese Kuhs
NCTM, 1992

Designed as a companion to the book, Mathematics Assessment: Myths, Models, Good Questions, and Practical Suggestions, this video helps explore alternative approaches to mathematics assessment with classroom dramatizations and commentary by a panel of mathematics educators.

Mathematics: What's the Big Idea?
Annenberg/CPB Project, 1997

This series of videotapes offers motivation and tools to teachers who want to explore ways of changing how to teach math. Using a variety of models, activities, and video clips from the Annenberg/CPB Math and Science Collection, K-8 teachers can reflect upon their own practice, and discuss ideas for innovation in teaching with their colleagues.

Project T.I.M.E. (Teachers Improving Mathematics Education)
University of California, Santa Barbara

This videotape highlights a specific staff development project that supported teachers in an effort to teach mathematics in a more meaningful manner that was aligned with the NCTM standards. Even though the tape is specific to a particular project, it highlights the strategies that made the staff development successful and these features are replicable in other settings. A variety of classroom scenes are included in the footage.

Resources for Science Literacy: Professional Development
Project 2061
American Association for the Advancement of Science (AAAS)
Oxford University Press, 1997

This CD-ROM includes the full text of Science for All Americans, detailed analysis comparing Benchmarks to the National Science Education Standards, and syllabi from college courses based on Science for All Americans. There is a database of books for general reading on science, mathematics, and technology as well as a summary and bibliography on cognitive research. A tape guide with presentation outlines, transparency masters and handout masters is also provided.

The Science of Teaching Science
Annenberg/CPB Project, 1997

K-8 teachers can take time to examine their own teaching practices in light of new research-based teaching methods and the experiences of their peers. This videotape provides eight different aspects of teaching science through an in-depth look into another teacher's classroom.

Science Standards: Making Them Work for You
Judy Famellette and Loraine Corfield
ASCD, 1995

Nine elementary classroom examples give ideas for active, hands-on science lessons and new ways to make science learning meaningful. Through the videotapes, examples are offered to show how to encourage students to think and hypothesize about their observations, the importance of students making presentations and creating graphics, promote learning through simple tools and primary resource materials, and appropriate assessments for activity-based science education.

Shortchanging Girls, Shortchanging America
American Association of University Women, 1991

This video describes research from the late 1980s and early 1990 documenting the ways that girls are shortchanged by our schools. This video can be used to provoke discussion about equity in the classroom.

Understanding Teaching: Implementing the NCTM Professional Standards for Teaching Mathematics
Arizona State University
ASCD, 1995

Through this CD-ROM, one will be able to view teachers implementing the NCTM standards in daily instruction, explore learning outcomes and recommended steps for teaching mathematics, and see how the principles of hands-on mathematics learning and math as problems solving are implemented in classroom routines. There is a multimedia lesson planning workshop with suggestions for performance tasks, classroom environment, and lesson content.

Valuing Diversity in Children's Learning: Making It Happen in Our Schools
Elizabeth Hebert
ASCD,1996

This audio tape is a recording of Ms. Hebert's presentation at the 1996 ASCD convention where she describes her school's journey in the process of instituting portfolios for each child in her elementary school. She describes the successes and the pitfalls of such an adventure.

Video Case Studies in Science Education
The Annenberg/CPB Math and Science Collection, 1997

This collection of videotapes, produced by the Harvard-Smithsonian Center for Astrophysics, comes with a facilitator's guide to promote thoughtful study of the tapes. The collection of six tapes profiles 25 teachers from grades kindergarten through eighth grade. Each case is organized in three phases: introducing the case, trying new ideas, and reflecting and building on change. There are classroom scenes and interviews with the teachers. Each teacher chose an issue to focus on such as designing grade-level science activities, increasing student's role in their learning, meeting the needs of diverse learners, assessing fairly and accurately. The facilitator's guide includes suggestions for discussion questions and ideas for organizing a staff development program using these tapes.

What Matters Most: Teaching for America's Future
The National Commission on Teaching & America's Future, 1996

This video illustrates a variety of ideas for improving the school environment for teachers. The tape includes vignettes of professional development schools, mentor-relationships for new teachers, and examples of re-structured schools to highlight the recommendations in the Commission's report of the same title. The tape promotes discussions about models for increasing teacher professionalism and empowerment.

McREL

Mid-continent Regional
Educational Laboratory

2550 South Parker Road, Suite 500
Aurora, CO 80014
Telephone: 303-337-0990
Fax: 303-337-3005
http://www.mcrel.org

NOTICE

Reproduction Basis

☑ This document is covered by a signed "Reproduction Release (Blanket)" form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

☑ This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").